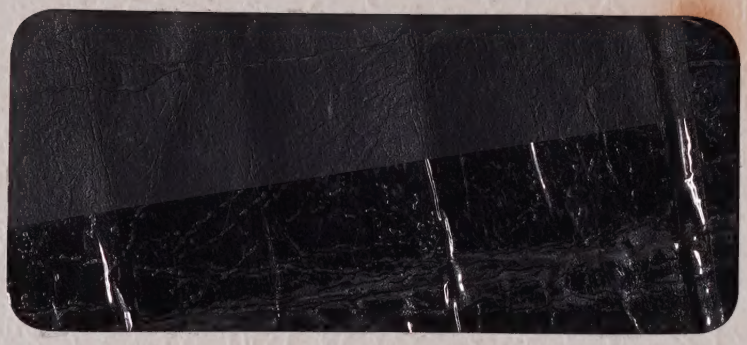

SINGER
INSTRUMENTATION

INSTRUCTION MANUAL

sweep signal generator

630 SERIES

Serial ____ ____

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Schematics

900604	Diode Shaper
900599	Cathode Supply
900766	Low Voltage Power Supplies
900600	Sweep Circuit
900652	Markers Circuit
900661	Reference Oscillator and Modulator
900602	Leveler Circuit
900598	Helix Overcurrent
900597	Transfer Oscillator
900673	Elevated Supply
900660	Sweep Signal Oscillator

SECTION 1 - INTRODUCTION

1.1 SPECIFICATIONS

MODEL	FREQUENCY RANGE	LEVELED OUTPUT POWER	POWER VARIATION	RESIDUAL AM	RESIDUAL FM MAXIMUM	VSWR	RF CONNECTOR
631 A	1 to 2 Gc	More than 50 mw	±0.3 db	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
631A-S1	1.4 to 2.5 Gc	More than 50 mw	±0.3 db	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
632A	2 to 4 Gc	More than 40 mw	±0.3 db	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
633A-S1	3.5 to 6.75 Gc	More than 10 mw	±0.5 db	40 db below signal level.	60 Kc peak unleveled. 80 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
633A	4 to 8 Gc	More than 20 mw	±0.5 db	40 db below signal level.	60 Kc peak unleveled. 80 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
634A	7 to 11 Gc	More than 6 mw	±0.5 db	40 db below signal level	75 Kc peak unleveled. 100 Kc peak leveled.	Less than 2.5 : 1	Type 'N' Female
635A	8 to 12.4 Gc	More than 20 mw	±0.5 db from 8.2 to 12.4 Gc	40 db below signal level	75 Kc peak unleveled. 100 Kc peak leveled.	Less than 2.5 : 1	UG135/U Flange
637A	12.4 to 18 Gc	More than 10 mw	±0.75 db	40 db below signal level.	100 Kc peak unleveled. 150 Kc peak leveled.	Less than 2.5 : 1	UG419/U Flange

- SPECIFICATIONS -

MODEL	FREQUENCY RANGE	POWER OUTPUT	LEVELED OUTPUT POWER VARIATION	RESIDUAL AM	RESIDUAL FM MAXIMUM
631D	1 to 2 Gc	+ 13 dbm to - 40 dbm	Less than ±0.5 db from + 13 dbm to - 10 dbm; less than ±2.0 db at - 40 dbm.	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.
631D-S1	1.4 to 2.5 Gc	+ 13 dbm to - 40 dbm	Less than ±0.5 db from + 13 dbm to - 10 dbm; less than ±2.0 db at - 40 dbm.	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.
632D	2 to 4 Gc	+ 10 dbm to - 40 dbm	Less than ±0.5 db from + 10 dbm to - 10 dbm; less than ±2.0 db at - 40 dbm.	Non-harmonics 40 db and harmonics 20 db below signal level.	25 Kc peak unleveled. 50 Kc peak leveled.
633D	4 to 8 Gc	+ 8 dbm to - 45 dbm	Less than ±0.5 db from + 8 dbm to - 12 dbm; less than ±2.0 db at - 45 dbm.	Non-harmonics 40 db and harmonics 20 db below signal level.	60 Kc peak unleveled. 80 Kc peak leveled.
633D-S1	3.5 to 6.75 Gc	+ 8 dbm to - 45 dbm	Less than ±0.5 db from + 8 dbm to - 12 dbm; less than ±2.0 db at - 45 dbm.	Non-harmonics 40 db and harmonics 20 db below signal level.	60 Kc peak unleveled. 80 Kc peak leveled.

Frequency Control:	Three controls continuously adjustable over entire frequency range. F_1 for start frequency, F_2 for end frequency and F_0 for symmetrical narrow sweep. All three can be used for single frequency operation. Frequency calibration better than 1% (leveled operation).
Frequency Stability:	Better than 0.01% per degree centigrade.
RF Power Calibration:	Within ± 0.25 db plus leveled power variation.
Marker Control:	Three markers (M_1 , M_2 , and F_0) continuously adjustable over entire frequency range. Marker calibration: better than 1% (leveled operation). Marker width: approximately 0.05% of frequency range. Marker appears as a reduction of rf power and is adjustable from zero to greater than 10%.
Wide Sweep: ($F_1 \rightarrow F_2$)	Continuously adjustable from 2% to 100% of the full band range.
Symmetrical Sweep: ($F_0 \pm \Delta F$)	Continuously adjustable from 0 to ± 5% of band about any center frequency (F_0).
Sweep Rate:	Continuously adjustable from 10 milliseconds to 100 seconds per sweep.
Sweep Trigger:	Four modes; EXTERNAL, FREE RUN, LINE and MANUAL (single sweep). In EXTERNAL mode a 10 microsecond or longer pulse, greater than 2 volts amplitude, triggers sweep. In LINE mode, sweep is triggered by the input line voltage. In MANUAL mode, sweep is triggered by front panel push button.
Sweep Output:	In SINGLE FREQUENCY mode, F_0 output is a zero to 15 volt signal varying in direct proportion to F_0. In swept operation mode, $F_1 \rightarrow F_2$, sawtooth wave begins at zero volts and increases linearly to 15 volts regardless of start and stop frequency settings. Output impedance is approximately 10 K ohms. In SINGLE FREQUENCY mode F_1 output is zero; F_2 output is 15 volts.
Blanking Output:	A+50volt signal is available during sweep retrace. Output impedance is approximately 10 K ohms.

Amplitude Modulation:	Three modes; EXTERNAL, OFF and internally generated SQUARE WAVE. Square wave symmetry within 5%. Rise time; less than 10 microseconds. Repetition rate; 800 to 1200 cps continuously adjustable. Externally applied signal of -15 volts reduces amplitude to zero. Rise and fall time; 10 microseconds. Input impedance is approximately 10 K ohms.
Frequency Modulation:	Externally applied signal of 1.5 volts peak to peak, produces a 10% deviation of full frequency range. Positive going voltage increases frequency. FM can be applied during all modes of operation. Response; dc to 10 kc. Input impedance; 15 K ohms.
Metering:	Backward wave oscillator helix or collector current, balance and power set.
Power Input:	105 to 125 volts, or 210 to 250 volts, 50/400 cps. approximately 150 VA for models with permanent magnet backward wave oscillator tubes. 105 to 125 volts, or 210 to 250 volts, 60 cps approximately 550 VA for models with solenoid focused backward wave oscillator tubes.
Dimensions:	See Figure 1-1
Weight:	Approximately 60 pounds for non-solenoid models. Approximately 75 pounds for solenoid models.

1.2 DESCRIPTION

The ALFRED 630 Series Sweep Signal Generator is a general purpose wide band signal source. The unit utilizes a voltage tuned backward wave oscillator tube powered by low drift, low ripple, precisely regulated power supplies.

The output frequency can be varied proportionally by an external signal or linearly with time over intervals from 0.01 to 100 seconds by an internal sawtooth generator or manually adjusted to any frequency in the band. The swept rf output can be either single or recurrent. Single sweep can be triggered by a panel push button or an external signal. Recurrent sweep can be synchronized to the internal power line frequency, left to free run or triggered by an external signal.

For X-axis drive of oscilloscopes or recorders a positive going sweep voltage, proportional to frequency, is available at the SWEEP OUTPUT jack. Two calibrating voltages are available for setting up recorders. Peak voltage is 15 volts. During sweep retrace, a +50 volt pulse is available at the BLANKING OUTPUT jack for oscilloscope blanking or recorder pen control. A front panel control selects rf ON or OFF during sweep retrace.

Three electronically generated frequency marker pips are provided. They are short, triangular, negative pulses which modulate the rf and may be used for calibration purposes. Pulse width is less than 0.05% of the total frequency range and amplitude is adjusted by a front panel control. The calibrated dial provides clear presentation of markers, sweep start and sweep end frequencies giving a total of five calibrated frequency points during $F_1 \rightarrow F_2$ swept operation.

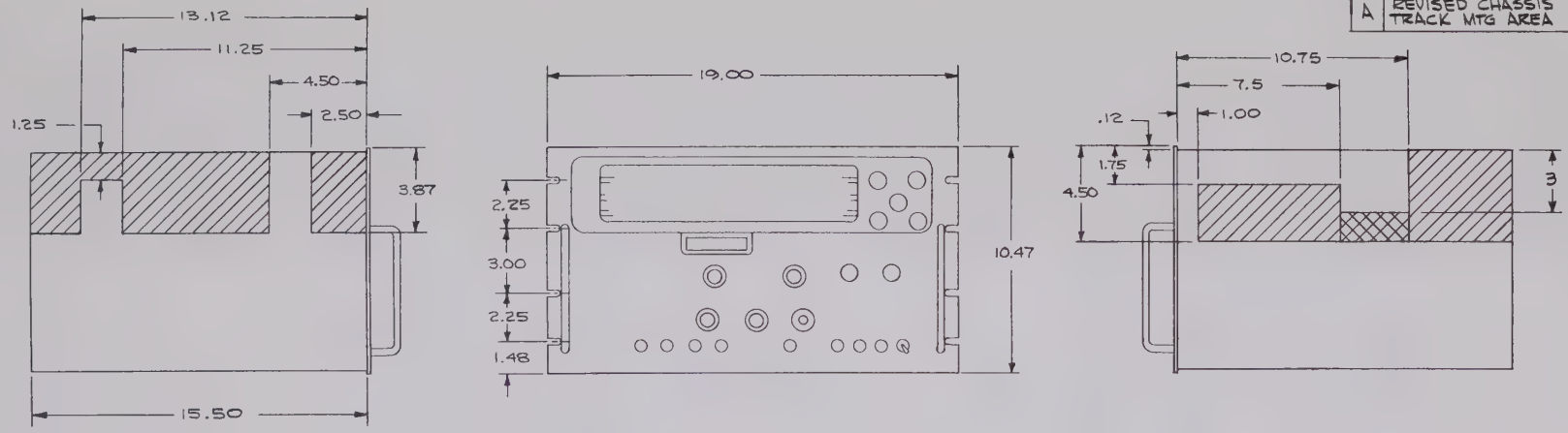
By front panel selection the rf signal may be amplitude modulated by either an internally generated square wave or by an external source. The square wave is continuously adjustable from 800 to 1200 cps. An externally applied negative signal is dc coupled and circuit response permits pulse rise and fall times of better than 10 microseconds.

FM modulation is available in all modes of operation. The input is dc coupled and response is 1% of the band per 0.1 millisecond.

Leveling of the output is accomplished by a closed loop circuit. Dual barretters are used to sample and compare the rf power to a highly stable reference. The difference, or error voltage, is applied to the backward wave oscillator to continuously correct any variations in output power. In the 630D model, a 0 to 60 db variable attenuator, calibrated in dbm, provides a constant and predetermined power level during all modes of operation. In the 630A model (no attenuator) adjusting the power-set meter to red line provides a constant, resettable, absolute power level.

The backward wave oscillator tube does not require rf adjustment, is encapsulated for protection and is easily replaced. A front panel meter monitors backward wave oscillator tube currents. Protective circuits reduce the likelihood of damage to the tube.

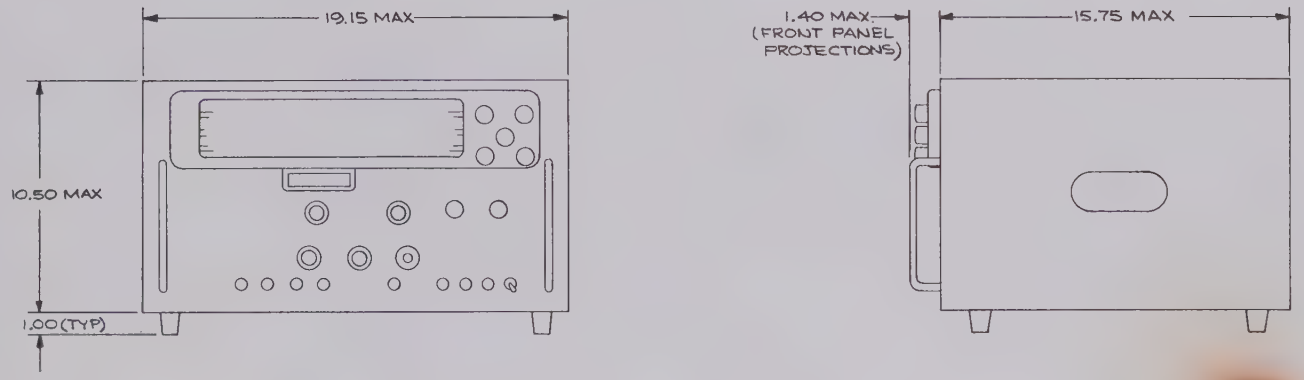
SYM	DESCRIPTION	NO.	DATE	BY
A	REVISED CHASSIS TRACK MTG AREA	2	5/16/64	DJM



LEFT SIDE

INSTRUMENT WITH SIDE PANELS REMOVED
(FOR RACK MOUNTING) - SEE LEGEND

RIGHT SIDE



LEGEND

- AREA WHERE CHASSIS TRACK MTG. HOLES MAY BE LOCATED FOR ALL MODELS.
- AREA AVAILABLE FOR NON-SOLENOID MODELS BUT NOT AVAILABLE FOR SOLENOID MODELS.

INSTRUMENT WITH SIDE PANELS INSTALLED

FIGURE 1-1

NOTES:

1. THE MODEL 630 SERIES INSTRUMENT MAY BE EITHER BENCH MOUNTED OR RACK MOUNTED.
2. FOR RACK MOUNTING REMOVE BOTH SIDE PANELS.
3. FOR INSTALLATION OF CHASSIS TRACKS, DRILL MTG. HOLES ONLY IN SHADED AREAS INDICATED ABOVE.
4. APPROXIMATE WEIGHT OF INSTRUMENT IS 60 LBS. (SLIGHTLY HEAVIER FOR SOLENOID MODEL INSTRUMENTS).

ITEM	REQD	PART NO.	DESCRIPTION
LIST OF MATERIAL			

MATERIAL

MATERIAL STOCK NO.

FINISH OR TREATMENT

		DATE
DRAWN	Dave Presley	10/17/63
ENG	Y. Oshima	10/17/63
PROD	[illegible]	10-17-63

SCALE 1:4

OUTLINE & DIMENSIONAL DATA FOR MODEL 630 SERIES INSTRUMENT

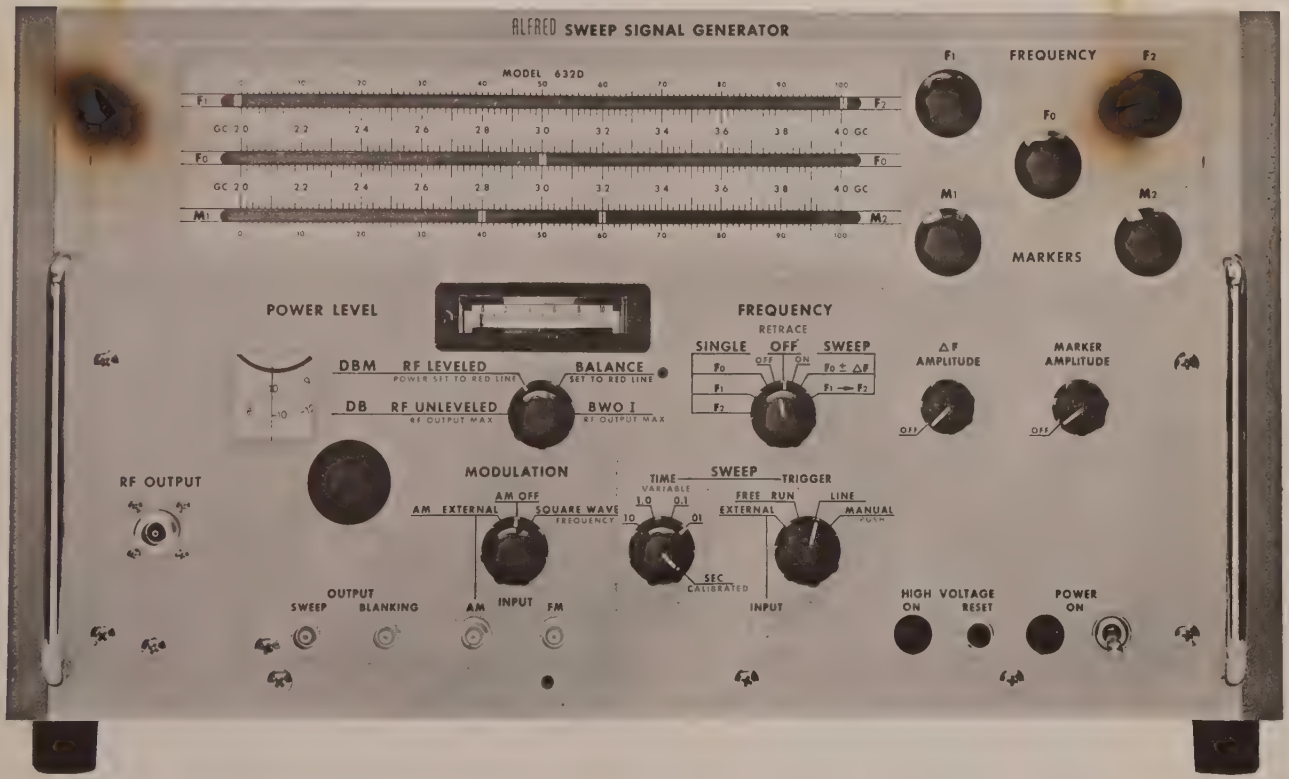
DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005, ANGLE ± ½°
UNLESS INDICATED OTHERWISE

NEXT ASSY: 630 SERIES
USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

990113C

SHEET 1 OF 1



FRONT PANEL

FIGURE 2-1

SECTION 2 - OPERATING INSTRUCTIONS

2.1 FRONT PANEL CONTROLS

A. FREQUENCY CONTROLS: Located to the right of the calibrated dial are three frequency controls; F_1 , F_0 , and F_2. They are used in conjunction with the three frequency indicators and the calibrated dial to set the desired frequencies.

B. MARKER CONTROLS: Below the three frequency controls are two marker controls; M_1 and M_2. They are used in conjunction with the two marker indicators and the calibrated dial to set the desired marker frequencies. In the $F_1 \rightarrow F_2$ mode, F_0 is also a marker.

C. FREQUENCY MODE SELECTOR - RETRACE CONTROL

FREQUENCY MODE SELECTOR

OFF: When in this position the backward wave oscillator is biased off and no rf appears at the output. In single frequency operation, the OFF position is used to zero external meters and establish a zero power reference. If the instrument is to be left on but in a standby condition, the FREQUENCY mode selector should be in the OFF position.

F_0: In this position the output of the generator is a single frequency determined by the F_0 indicator. For control of the X-axis of X-Y recorders, a voltage proportional to the F_0 frequency is provided at the SWEEP OUTPUT jack. The F_0 mode can be used as a pre-set frequency for spot frequency checks in conjunction with F_1 and F_2.

F_1: In this position the output of the generator is a single frequency determined by the F_1 indicator. A calibration voltage is provided at the SWEEP OUTPUT jack and can be used to set the start point on oscilloscopes and recorders for use in the SWEEP mode. The F_1 mode can be used as a pre-set frequency for spot frequency checks in conjunction with F_0 and F_2.

F_2: In this position the output of the generator is a single frequency determined by the F_2 indicator. A calibration voltage is provided at the SWEEP OUTPUT jack and can be used to set the end point on oscilloscopes and recorders for use in the SWEEP mode. The F_2 mode can be used as a pre-set frequency for spot frequency checks in conjunction with F_0 and F_1.

$F_1 \rightarrow F_2$: In this position the output of the generator is a swept frequency beginning at the F_1 frequency indicator and ending at the F_2 frequency indicator. The sweep frequency range (from F_1 to F_2) can be varied from 100% to 2% of the frequency band of the generator. When in this mode marker pips are provided at the F_0 , M_1 and M_2 frequency settings. In this position, a sweep voltage of 15 volts amplitude appears at the SWEEP OUTPUT jack.

$F_0 \pm \Delta F$: In this position the output of the generator is a swept frequency which is symmetrical about the F_0 frequency. ΔF can be varied from 5% of the band to zero. The $F_0 \pm \Delta F$ mode can be used to examine small perturbations, seen when using the $F_1 \rightarrow F_2$ mode, by setting the F_0 marker pip at the perturbation frequency and changing the mode from $F_1 \rightarrow F_2$ to $F_0 \pm \Delta F$. When in this mode marker pips are provided at the M_1 and M_2 frequency settings. In this position a sweep voltage, of 15 volts amplitude, appears at the SWEEP OUTPUT jack.

RETRACE CONTROL

Concentric with the FREQUENCY mode select-

or. This control is operative only in the SWEEP modes. In the OFF position, the rf is off during retrace.

D. METER CONTROL: This control is located directly beneath the meter.

BACKWARD WAVE OSCILLATOR CURRENT (BWO I): In this position backward wave oscillator current can be measured on the meter. By selecting the appropriate position of the rear panel switch (HELIX/DELAY LINE or COLLECTOR) tube current can be read. With backward wave oscillator tubes that have both a helix and collector, the full scale reading is 20 ma when S913 is in the COLLECTOR position. In the HELIX/DELAY LINE position, full scale reading is 5 ma. With tubes that have an inter-digital delay line or helix but no collector, the full scale reading is 50 ma when S913 is in the HELIX/DELAY LINE position. The COLLECTOR position is inoperative because collector currents do not exist.

BALANCE: In this position the backward wave oscillator is biased off enabling the barretters to be balanced by the front panel screwdriver adjustment. For correct adjustment the meter pointer is set to red line.

RF LEVELED: In this position the rf output is maintained constant across the frequency band. In the 630D types the magnitude of the output is determined by the setting of the attenuator, which is calibrated in dbm, when the meter is set to red line by the concentric POWER SET control. For the 630A types the output is leveled at the value specified on Addendum A (located in envelope at rear of manual) when the meter is set to red line by the concentric POWER SET control.

RF UNLEVELED: In this position the rf output (for 630D types) is the maximum the tube can supply minus the sum of the insertion loss and the setting of the attenuator. In the 630A types the output is the maximum the tube can supply.

POWER SET CONTROL: Concentric with the METER control. In the 630D types the POWER SET control sets the power level so the attenuator correctly indicates power in dbm and in the 630A types it sets the specified power level. Both are accomplished by adjusting the control so the meter pointer is exactly on red line when the METER control is in the RF LEVELED position.

E. ATTENUATOR CONTROL: (630D type only). The ATTENUATOR control, located at the lower right corner of the scale, adjusts the amount of attenuation in the output circuit. When the output is leveled the scale is calibrated in dbm. When the output is unleveled the scale provides a means for adjusting relative power in db. Scale readings should always be taken directly below the solid black line.

F. MODULATION CONTROL: This control is located below the METER control.

AM OFF: When in this position, the rf output is unmodulated.

AM EXTERNAL: When in this position a negative signal, applied to the AM INPUT jack, will decrease the rf output.

SQUARE WAVE: In this position, the rf output is modulated by an internally generated square wave whose frequency can be varied between 800 and 1200 cycles per second by the SQUARE WAVE FREQUENCY control which is concentric with the MODULATION control.

G. SWEEP TIME CONTROL: This control sets the time to sweep from the start frequency point to the end frequency while in the $F_1 \rightarrow F_2$ sweep mode and the time to sweep from $F_0 - \Delta F$ to $F_0 + \Delta F$ in the $F_0 \pm \Delta F$ sweep mode. There are

four major settings: .01, 0.1, 1.0 and 10 seconds, with continuous intermediate settings adjustable up to 100 seconds by the concentric knob. When the concentric knob is full clockwise, the sweep time is calibrated to the value indicated by the SWEEP TIME control: .01, 0.1, 1.0 or 10 seconds.

H. SWEEP TRIGGER CONTROL

EXTERNAL: When in this position a positive signal applied to the EXTERNAL INPUT jack will trigger the sweep.

FREE RUN: In this position the sweep is triggered immediately upon the completion of a cycle.

LINE: In this position the sweep trigger is synchronized with the input line frequency or a sub-multiple of the line frequency, depending upon the setting of the sweep time control.

MANUAL: In this position the sweep is triggered by pressing the concentric button.

I. ΔF AMPLITUDE CONTROL: This control varies the width of the symmetrical sweep about F_0 when the FREQUENCY mode selector is in the $F_0 \pm \Delta F$ mode. In full clockwise position, the width is at least ± 5% of the frequency band.

J. MARKER AMPLITUDE CONTROL: This control sets the amplitude of the marker pulses that are visible in the swept rf output. The type of circuit used results in a pulse whose width is also reduced as the amplitude is reduced.

K. HIGH VOLTAGE RESET: If, for some reason, the helix current limitation of the backward wave oscillator is exceeded, the high voltage will automatically turn off. If correct adjustments are made and the reset button is pressed, high voltage will be restored.

2.2 INITIAL TURN-ON

2.2.1 POWER REQUIREMENTS

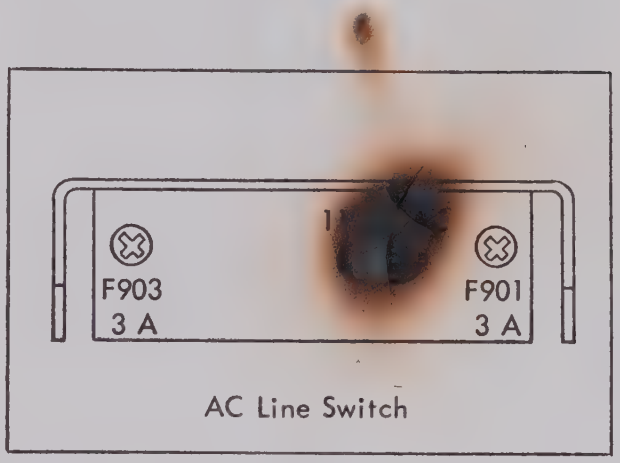


Figure 2-2

The unit is normally connected at the factory for operation at 105 to 125 volts and 50 to 400 cycles ac (115 volts nominal). However, provisions are made for easy conversion to operation at 210 to 250 volts, 50 to 400 cycles ac (230 volts nominal).

With the top cover removed locate the power switch plate labeled 115 VAC. (See Figure 2-2) By removing and reversing this plate the switch can be moved to the left. Replace the plate with 230 VAC showing. Replace the 8 ampere main fuse (in back of instrument) with a 6 ampere fuse.

2.2.2 INITIAL TURN-ON PROCEDURES

Prior to regular operation of the unit, the following test should be performed.

1. Set the METER control to BWO I.
2. Set FREQUENCY mode selector to SINGLE; F_0.
3. Set FREQUENCY indicator, F_0 , to the low end of the scale.

4. Set MODULATION control to AM OFF.

5. Move the METER switch (S913) at rear of the instrument to HELIX/DELAY LINE.

6. Turn POWER switch to ON.

NOTE: Time delay relays used in the Model 630 Series delay high voltage turn on for approximately 60 seconds after the POWER switch is turned ON to allow a brief warm-up period for the backward wave oscillator filament. If the ac power is off for only an instant, the normal 60 second delay will occur before high voltage returns.

7. When high voltage appears, measure the helix current on the front panel meter. At this setting the full scale reading is 5 ma, and the helix current should be less than the trip out current specified in Chart #1, Section 5. Move METER switch on rear of instrument to COLLECTOR. Observe the collector current on the meter. The full scale reading is 20 ma and any value between 5 and 15 ma indicates correct collector current. (See tube data sheet located in envelope at rear of manual for exact values.)

8. With tubes that have delay lines (no collector) the METER switch should be set to HELIX/DELAY LINE. With these tubes the full scale reading is 50 ma and the value should be between 10 and 40 ma. The collector or delay line current can vary from instrument to instrument and no definite value is therefore established. (See tube sheet, located in envelope at rear of manual, for your tube's specific values.) If the above procedure checks out, the unit is ready for operation.

2.3 OPERATING PROCEDURE

Turn POWER switch to ON. Set the METER control to BALANCE and adjust the meter to read red line by using the front panel screw driver adjust.

NOTE: After approximately ten minutes of operation, check for red line drift. If drift is noted, the BALANCE should be readjusted.

After high voltage appears, the instrument is ready for operation. If leveled output is desired, the METER control is set to RF LEVELED and the concentric POWER SET control adjusted so the meter reads red line. This establishes the power level. In the 630D types the attenuator setting correctly indicates power in dbm. In the 630A types the output level is that specified for your instrument on Addendum sheet A located in envelope at rear of manual.

If unleveled output is desired, the METER control is set to RF UNLEVELED. In the 630D types the attenuator now provides a means for adjusting the power and is calibrated in db. In the 630A types the output is the maximum the backward wave oscillator tube can supply.

CAUTION: When using the RF UNLEVELED position, the rf power output can be as great as 200 milliwatts.

For wide sweep operation the FREQUENCY mode selector is set to SWEEP; $F_1 \rightarrow F_2$ and the F_1 and F_2 FREQUENCY indicators are set to the desired start and end frequency points. The SWEEP; TIME and TRIGGER controls can be adjusted to the desired time and trigger conditions.

For narrow sweep operation the FREQUENCY mode selector is set to SWEEP; $F_0 \pm \Delta F$ and the F_0 FREQUENCY indicator is used to set the desired frequency.

The ΔF AMPLITUDE control can be adjusted to the sweep width desired. A maximum value of at least $\pm$ 5% of the frequency band of the instrument is available.

Example: Frequency band of instrument = 2 to 4 Gc
Band Coverage = 2 Gc

5% of 2 Gc = 100 Mc (maximum ΔF)

When sweeping in either the wide or narrow sweep modes, markers are available by turning up the MARKER AMPLITUDE control. In the $F_1 \rightarrow F_2$ mode, there are three markers available whose frequencies are set by the F_0, M_1 and M_2 control knobs. In the $F_0 \pm \Delta F$ mode two markers are available; M_1 and M_2.

During either wide or narrow sweep there is provided, at the SWEEP OUTPUT jack a sawtooth waveform whose amplitude is +15 volts peak. Also provided, at the BLANKING OUTPUT jack, is a +50 volt pulse which occurs during retrace.

For single frequency operation the FREQUENCY mode selector can be set to SINGLE; F_0, F_1 or F_2 with the desired frequency set by the F_0, F_1, or F_2 control knobs. For manual sweep, the FREQUENCY mode selector is set to SINGLE F_0 and the F_0 control knob is used to sweep the frequency manually. During manual sweep a dc voltage, proportional to F_0 frequency, is provided at the SWEEP OUTPUT jack.

2.4 REMOTE FREQUENCY OPERATION

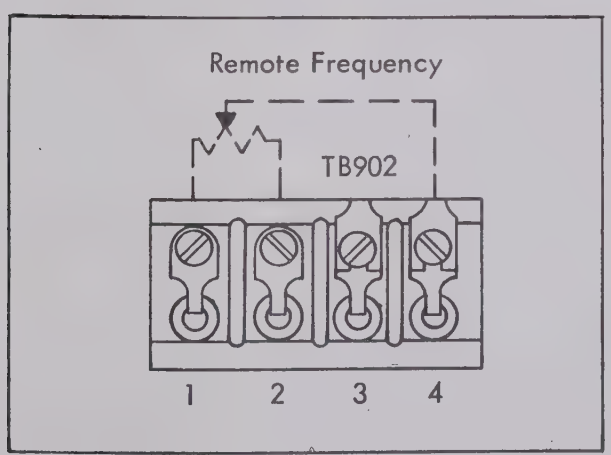


Figure 2-3

If it is desired to control the F_0 FREQUENCY at some distance from the instrument, terminal block TB902 is provided at the rear of the instrument for this purpose. See Figure 2-3. Remove the jumpers at TB902-3 and -4 and insert a 1 K Ωpotentiometer as indicated by the dotted lines.

NOTE: Shielded wires should be used to connect the external 1 K Ωpotentiometer to the terminal. (A shielded three wire cable is satisfactory.)

SECTION 3 - CIRCUIT DESCRIPTION

3.1 GENERAL

The high frequency rf energy, produced by the unit, is generated by a backward wave oscillator tube. The tube is controlled by highly stable power supplies. Through proper voltage control the backward wave oscillator provides a means of producing either a variable frequency (sweep mode) or a stable frequency (single mode). See Block Diagram, Figure 3-12.

The secondary reference voltages of the unit are the +15 and -15 volt supplies. The frequency of oscillation of the backward wave oscillator tube is primarily determined by the voltage between its cathode and helix. By referencing the cathode to helix potential to the + and -15 volt power supplies, a highly stable frequency is obtained.

To permit the unit to sweep from a start to an end frequency, a sweep generator is provided whose output is amplified by the cathode supply of the backward wave oscillator tube and causes the frequency to change linearly with time.

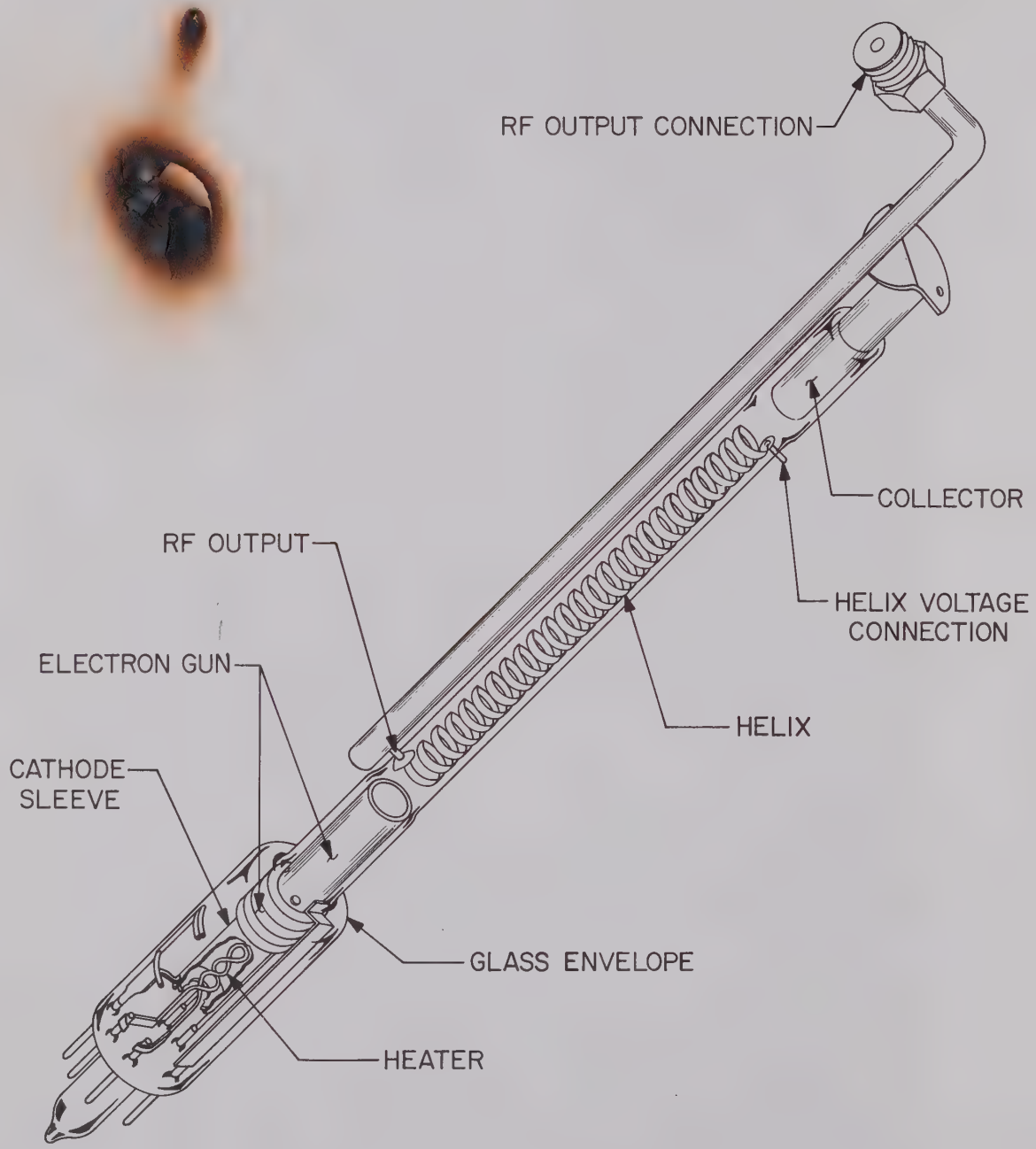
Auxiliary circuits provide modulation capabilities so that the amplitude of oscillation of the backward wave oscillator tube may be controlled. Two means are provided; a leveler circuit which maintains the amplitude constant, independent of its frequency of operation, and an on-off type modulator which provides amplitude modulation.

3.2 THE BACKWARD WAVE OSCILLATOR TUBE

The backward wave oscillator tube consists of an electron gun, a slow wave structure and a collector at the far end of the slow wave structure. The rf output of the tube is produced by the interaction between the electron beam and the electromagnetic field of a microwave signal developed on the slow wave structure. See Figure 3-1.

The electron gun contains a heated cathode and two or more aperture disc type control electrodes which help form the beam and control beam density. In a helix backward wave oscillator, it is desirable to have a hollow cylindrical electron beam since only the electrons that pass adjacent to the helix are fully effective in delivering energy to the wave. Electrons near the middle of the beam consume anode power but contribute little or nothing to the energy interchange that produces the backward wave oscillations. Surrounding the tube is a magnet which produces a strong axial field. This field focuses the electrons in the beam and allows movement only in the direction of the axis of the tube.

Oscillations, and hence the rf wave, begin in the backward wave oscillator in much the same manner as they begin in other oscillators. Noise waves are established on the helix from the shot noise coupled from the electron beam and from thermal energy developed at the input end of the tube. Waves are produced which travel in both directions in the helix, i. e., from gun to collector and from collector to gun. Since the desired wave in a backward wave oscillator must travel from the collector to the gun end, attenuators are placed in the tube which eliminate the forward moving waves. Amplification of the wave is produced by the interaction of the electrons in the beam and the electromagnetic field of the wave. To obtain this interaction, the electron beam must be at some critical velocity which is achieved by applying a dc voltage to the helix. Because the electromagnetic field is alternating, electrons in the beam are subjected to either an accelerating or decelerating field. Thus, the electrons entering the helix experience velocity modulation with a tendency for a bunch of electrons to be formed as they move through the helix. The critical areas of interaction are the spaces between the helix turns because the axial electric field is strong between helix turns and weak under the turns.



BACKWARD WAVE OSCILLATOR TUBE

FIGURE 3-1

To explain the bunching process let us examine a group of electrons as they travel from the gun to the collector end of the tube. Within this group there will be one electron, e, which corresponds to the zero point of the alternating axial field and is therefore unaffected by the signal on the helix. See Figure 3-2A. This electron experiences no acceleration from the electromagnetic field. However, an electron just to the left of e, e', encounters a positive axial field and is accelerated thus tending to catch up with e. Similarly, electron e", which is just to the right side of e, encounters a negative or decelerating field and so slows down and tends to be overtaken by electron e. The electrons centered about e are thus velocity modulated. This situation is repeated over and over again as the electrons centered about the reference electron pass one space after another. Now, by choosing the electron velocity so that at the collector end of the tube the phase difference between the wave and bunches in the beam is approximately one half cycle, the electron bunches will encounter relatively strong decelerating fields as they cross the spaces. Thus, the kinetic energy of the electrons is transferred to the backward wave. The amplitude of the backward wave builds up as it progresses toward the gun end of the tube because it passes more and more bunches from which it receives energy. At the same time, the alternating component of the beam current, i. e., the bunching becomes greater as the electrons progress toward the collector. See Figure 3-2B.

The operating frequency range of a particular backward wave oscillator tube is primarily determined by the dimensions of the slow wave structure. Since the most commonly used slow wave structure is a helix the following discussion will be based upon this type of tube.

It is well known that a slow wave structure will propagate a particular range of frequencies at constant axial velocity (the non-dispersive region) and above that range, the velocity of propagation increases with frequency (the dispersive region). The backward wave oscillator operates in the dispersive region and it will oscillate at the frequency for which the beam velocity is very nearly equal to the axial velocity of propagation. Figure 3-2C shows the variation of propagation velocity with frequency for a particular helix while Figure 3-2D shows how the beam velocity varies with the helix to cathode voltage.

From these figures it can be seen why the backward wave oscillator can be voltage tuned. By changing the helix to cathode voltage, the beam velocity changes and the frequency for which the velocity of propagation and the velocity of the beam are in synchronism changes. The helix dimensions, primarily diameter and pitch, are chosen so that the tuning voltages required for a particular frequency range are reasonable (usually about 200 to 2000 volts).

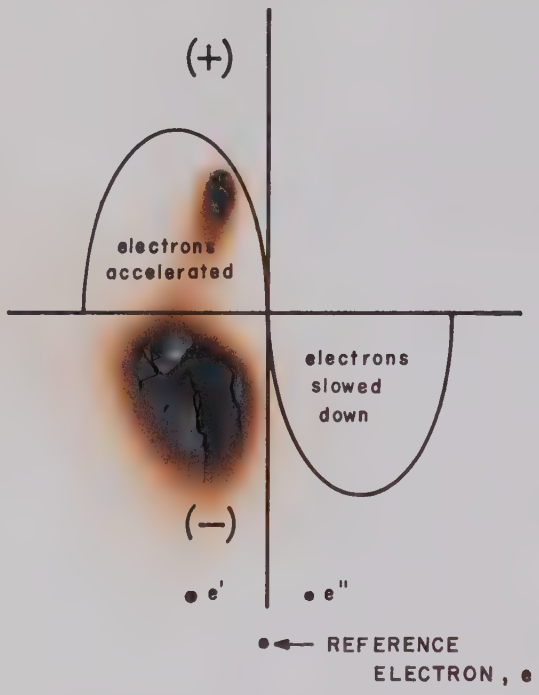
3.3 +15 AND -15 VOLT POWER SUPPLIES

The +15 and -15 volt power supplies provide the reference voltages for the unit. The primary reference for the unit is A2CR1, a 1N823A temperature compensated zener diode. This diode is used as the reference for the -15 volt supply. See Figure 3-3.

The -15 volt supply consists of a two stage differential amplifier, a driver, and a series regulator transistor. The amplifier consists of an input differential stage A2Q8; A2Q6 and A2Q7 the second differential stage and A2Q5 the driver for the series regulator transistor Q904.

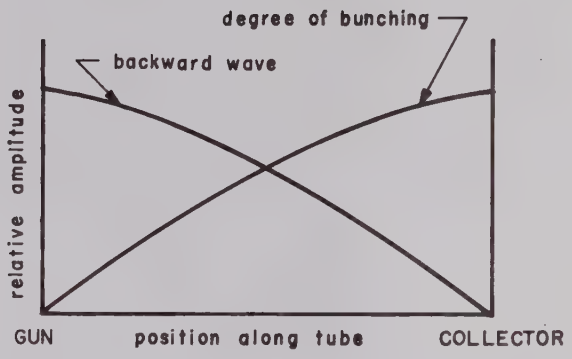
The use of metal film resistors in all critical circuits and matched transistors in the input stage at A2Q8, minimizes noise and drift in this supply. As in all closed loop feedback systems, tight control of phase response must be maintained. This is accomplished in this circuit by A2C5 and A2R34 located at the collector of A2Q6.

The -15 volts applied to A2R10 is used as the reference for the +15 volt supply. To control the output of the +15 volt supply, a two stage differential amplifier, a driver, and a series regulator transistor are also used. The amplifier consists of an input differential stage A2Q4; A2Q2 and A2Q3 the second stage and A2Q1 the driver stage. Q903 is the series regulator. The main phase re-



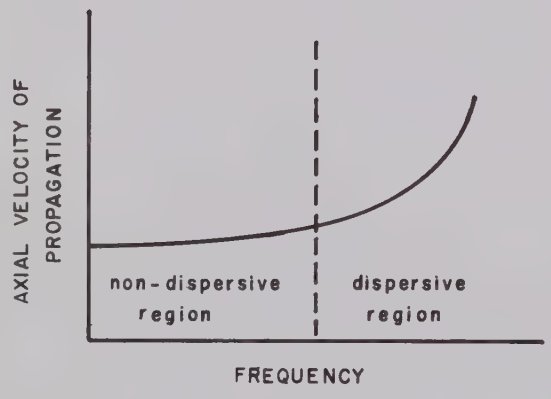
ELECTRON DISTRIBUTION

(A)



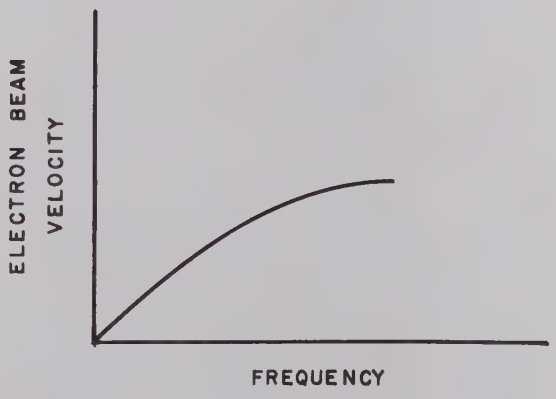
RELATIVE AMPLITUDE VS. POSITION ALONG TUBE

(B)



AXIAL VELOCITY OF PROPAGATION VS. FREQUENCY

(C)



ELECTRON BEAM VELOCITY VS. FREQUENCY

(D)

— FIGURE 3-2 —

sponse control for the +15 volt supply is A2C2 located across the collector of A2Q4.

The -15 volt supply is adjusted by A2R18 and the +15 volt supply is adjusted by A2R9.

3.4 +100 AND -50 VOLT POWER SUPPLIES

The +100 volt supply consists of a single stage differential amplifier A2Q9 and A2Q10, and a driver stage A2Q13, which drives the series regulator transistor Q901. A neon bulb, DS903 protects Q901 during turn-on. The +100 volt supply uses the -15 volt supply as a reference. See Figure 3-4.

The -50 volt supply consists of a two stage amplifier and a series regulator. The amplifier consists of A2Q12 the input stage and A2Q11 the driver. Q905 is the series transistor. The +15 volt supply is the reference for this supply. Phase response is controlled in the second stage by means of A2C10 and A2R37.

Diode A2CR2 is for temperature compensation and diode A2CR3 prevents transients from damaging A2Q12.

3.5 CATHODE SUPPLY

The cathode supply for the backward wave oscillator is an operational amplifier using both tubes and transistors. See Figure 3-5. It consists of a summing junction and a transistorized operational amplifier which controls the grids of the series regulator tubes V901, V902 and V903, located in the rear of the instrument. The summing junction and the operational amplifier are located on PC Board 100. The summing junction is at the base of Q101. A portion of the dc output is fed into the input of the summing junction, through high impedance emitter followers Q109 and Q110, forming a complete feedback system whose output can range from 150 to 2500 volts. The high impedance path makes it unnecessary to use high power resistors, thus minimizing power dissipation and hence thermal drift. Two diodes, CR101 and CR102, are used to compensate for any temperature deviations which occur in the emitter followers. Also in the feedback network is a non-linear, voltage sensitive attenuator consisting of a diode shaping network located on PC Board 900. It causes the output of the cathode supply to become non-linear with respect to its input and thus compensates for the non-linear tuning curve of the backward wave oscillator. Hence, the output frequency is directly proportional to the input voltage of the amplifier. For single frequency operation a voltage directly proportional to the frequency dial indicator position is applied to the amplifier input. During $F_1 \rightarrow F_2$ swept operation a linearly varying voltage, supplied by the sweep generator, is applied to the amplifier input. When in the $F_0 \pm \Delta F$ sweep mode a linearly varying voltage, supplied by the sweep generator, starts at $F_0 - \Delta F$ and sweeps to $F_0 + \Delta F$. This sweep voltage is applied to the amplifier input. The external modulation input is also connected to the amplifier input. A 1.5 volt signal will change the frequency by 10% of the band.

Tubes are used as the control elements for the high voltage supply because of their ability to withstand the high voltage required for the cathode of the backward wave oscillator. Transistors were chosen for the preamplifier because of their immunity to microphonics and low power requirements.

3.6 ANODE SUPPLY

The gun structure of all backward wave oscillators contains an anode which collimates the electron beam before it is accelerated to helix potential. The anode operates at an elevated potential with respect to the cathode and may vary from 50 to 200 volts depending upon the tube type. See Figure 3-6. Supply regulation is by a shunt regulator circuit consisting of one vacuum tube, which serves as the shunt regulator element, and three transistors. The transistor amplifier drives the shunt regulator tube and is located on PC Board 800. A reference voltage is furnished by the 70 volt grid bias supply. The anode voltage is adjusted by means of R806, the ANODE VOLTAGE ADJUST potentiometer.

3.7 FILAMENT SUPPLY

The filament supply is a regulated, variable, dc supply using a series regulator transistor and a two stage transistor amplifier. See Figure 3-6. The regulator amplifier, consisting of Q801 and Q802, is located on the elevated supplies' board, PC800. A zener diode, CR801, is the supply reference. The voltage may be adjusted by means of R backward wave oscillator HEATER VOL ADJUST, located on PC Board 800.

3.8 SWEEP GENERATOR

The sweep generator is located on PC Board 300 and PC Board 700. The four basic circuits on PC Board 300 are the Miller integrator consisting of Q304-Q307, the trigger circuitry consisting of Q308-Q311, a gating multivibrator consisting of Q301-Q302, and a retrace hold-off circuit consisting of Q312-Q314. See Figure 3-7.

The basic part of the sweep generator is the Miller integrator, a capacitive feedback dc amplifier which integrates its input voltage producing a linearly increasing output. This linear output creates a ramp which is used as the sweep in the instrument. The feedback capacitors for the Miller integrator are C701-C704, located on PC Board 700. The slope of the ramp output of Q307 is determined by the feedback capacitors and resistors R945 and R946.

Prior to the initiation of the sweep, Q301 in the multivibrator is off causing a positive voltage to be fed to the base of Q314. This causes the output of the retrace hold-off circuit Q312, to be positive which places a positive voltage on the base of Q304, the input to the Miller integrator circuit. This holds the output of the Miller integrator circuit, the collector of Q307, at approximately zero volts. A positive trigger applied to the base of Q309, through resistor R319, causes the Schmitt trigger, Q310 and Q311, to switch. The resulting negative spike on the collector of Q311 is fed to the base of Q302 in the multivibrator, through S906, causing the multivibrator to change states. Q302 is now off, or in the non-conducting state, while Q301 is on, or in the conducting state. This causes positive voltage to be removed from the base of both Q314 and Q304. The Miller integrator now generates a ramp function determined by the setting of switch S903, which selects the feedback capacitor and by the adjustment of R946, the SWEEP TIME multiplier control. When the ramp output of Q307 reaches 40 volts, CR302 becomes forward biased placing a positive voltage on the base of Q302, causing the multivibrator to change states. A positive voltage is again applied to the Miller integrator input, through the retrace hold-off circuit, causing the feedback capacitor to rapidly discharge. The Miller integrator output returns to zero volts. Thus, the sweep completes one cycle of operation and is ready for another. The sweep output from Q307 is channeled to the frequency controls through emitter follower Q705. The output of Q705 is also connected to emitter follower Q704, which in turn is connected to the SWEEP OUTPUT jack, J915.

In addition to the ramp output, this circuitry also provides a blanking voltage generated at the collector of amplifier Q303. The input to Q303 is taken from the collector of Q302 in the gating multivibrator circuit. Q303 amplifies the multivibrator output producing a +50 volt pulse which occurs during retrace and can be used for recorder pen lift or for oscilloscope blanking.

3.9 SWEEP TRIGGER MODES

The Model 630 provides four means of initiating or triggering a sweep. The choice is provided by the front panel SWEEP TRIGGER control whose four positions are FREE RUN, EXTERNAL, LINE and MANUAL. In the FREE RUN position the sweep is self-triggered. When the sweep returns to zero volts CR301 conducts, causing the sweep gate multivibrator to flip into the opposite condition, immediately retriggering the sweep cycle. In the EXTERNAL mode, transistors Q310 and Q311 form a Schmitt trigger which takes any arbitrary input waveform and transforms it into a step function. The step function is differentiated and the resultant spike is fed to CR301 to trigger the sweep. In the LINE mode a 6.3 volt ac rms voltage, at the line frequency, is supplied to the

Schmitt trigger thus synchronizing the sweep rate to the power line frequency. In the MANUAL mode the push button switch connects the Schmitt trigger to the +15 volt supply and allows just one trigger each time the button is depressed.

3.10 GRID SUPPLY

The 70 volt grid supply furnishes power to the grid driver amplifier. See Figure 3-6. It is shunt regulated and uses a two stage transistor differential amplifier to drive the shunt regulator transistor, Q803. A zener diode reference, CR802, is used to determine the supply output. Most of the components of this supply are located on PC Board 800.

3.11 MARKER CIRCUIT

See Figure 3-8.

The marker circuit provides wavemeter like pips to indicate preset frequencies set by the F_0 , M_1 or M_2 FREQUENCY control knobs. The markers are electronically generated from the sweep. A voltage is summed into the markers by the marker adjusting potentiometers M_1 , M_2 or F_0. The signal applied to the input of the cathode supply is also applied to the marker input. The marker has a condition which depends upon the backward wave oscillator beam voltage or the oscillating frequency of the backward wave oscillator as related to its input voltage. Hence, the same total current is summed into the helix supply and the action of the markers is identical in character to the helix supply. Thus, the marker generated is directly related to the frequency of oscillation of the backward wave oscillator tube.

A marker will appear when the input current corresponding to the frequency of oscillation is balanced by the current from the marker potentiometer. The first three stages of the marker circuit are amplifiers. The fourth stage is a high gain differential amplifier which is activated only when the input current is at the balance point (the point at which the frequency of oscillation is precisely that indicated by the marker). At this point, the voltage on R420 goes from a maximum to a minimum [illegible] the voltage on R422 goes from a minimum to a [illegible]. CR403 and CR404 from a diode adder [illegible] most negative voltage applied to either di[illegible] control the output. Hence, the outpu[illegible] connected to R422 and then R420. Co[illegible] the amplifier has a waveform which is [illegible] in shape. The markers are positioned [illegible] ntiometers R932 (F_0), R927 (M_1) and R92[illegible] (M_2).

All three marker circuits operate in exactly the same manner. The marker signals, from the three marker circuits, are added together with a dc voltage, which controls their amplitude and the sum is applied to emitter follower Q419, and then to the amplitude modulation circuits.

3.12 AMPLITUDE MODULATION AND LEVELING CIRCUITRY

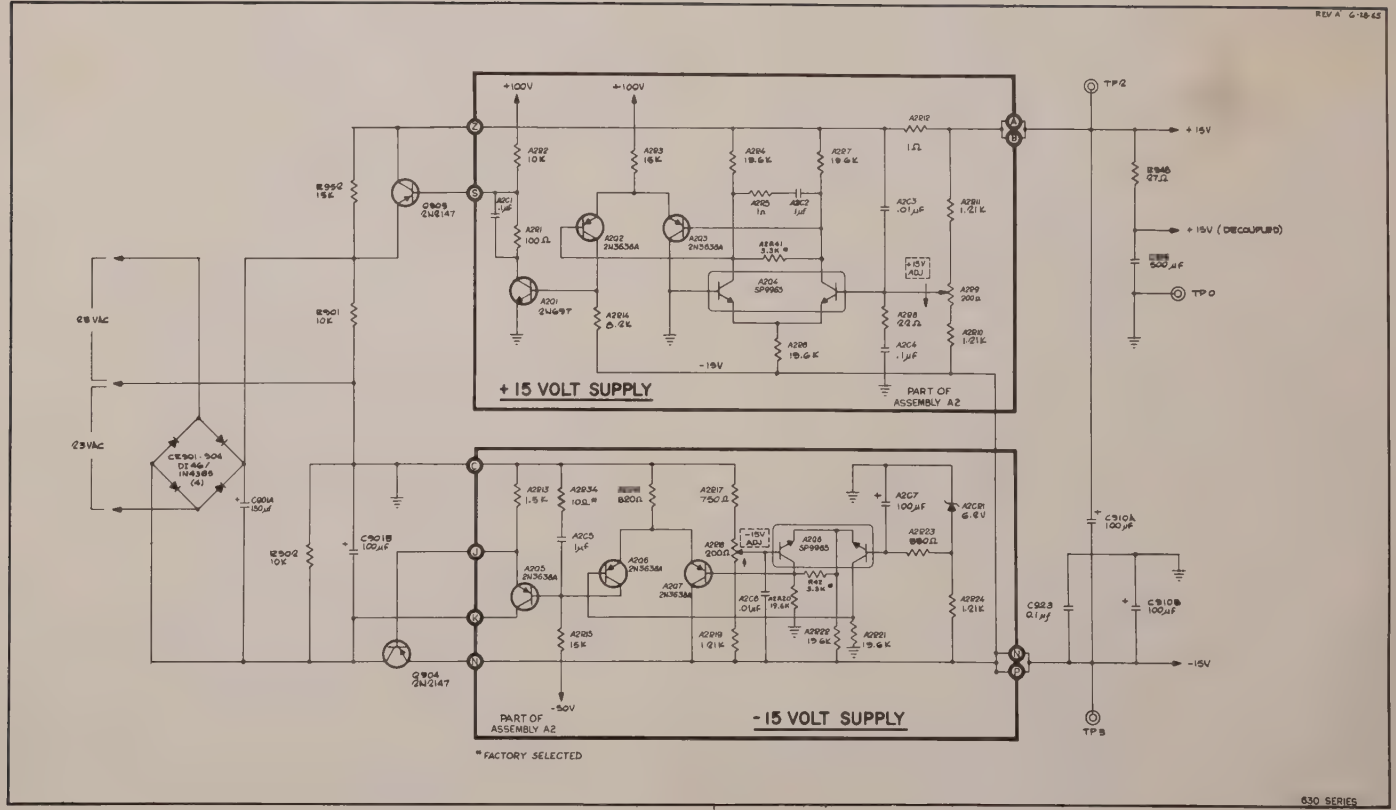
See Figures 3-9 and 3-10.

To control the amplitude of oscillation of the backward wave oscillator, a negative voltage must be applied between its grid and cathode. The operating potential of the cathode is anywhere between 150 and 2500 volts depending upon the tube used and the frequency of oscillation. A coupling scheme is required to transmit a controlling voltage which can be referenced to the cathode. The coupling scheme is a transfer oscillator whose output passes through high voltage capacitors to a detector circuit, which in turn controls the grid of the backward wave oscillator. Thus, any modulation applied to the backward wave oscillator is first reproduced in the transfer oscillator and again on the grid of the backward wave oscillator. (The microwave amplifier is thereby modulated by means of the modulation circuitry, which is near ground potential, through the transfer oscillator and then to the grid of the backward wave oscillator.)

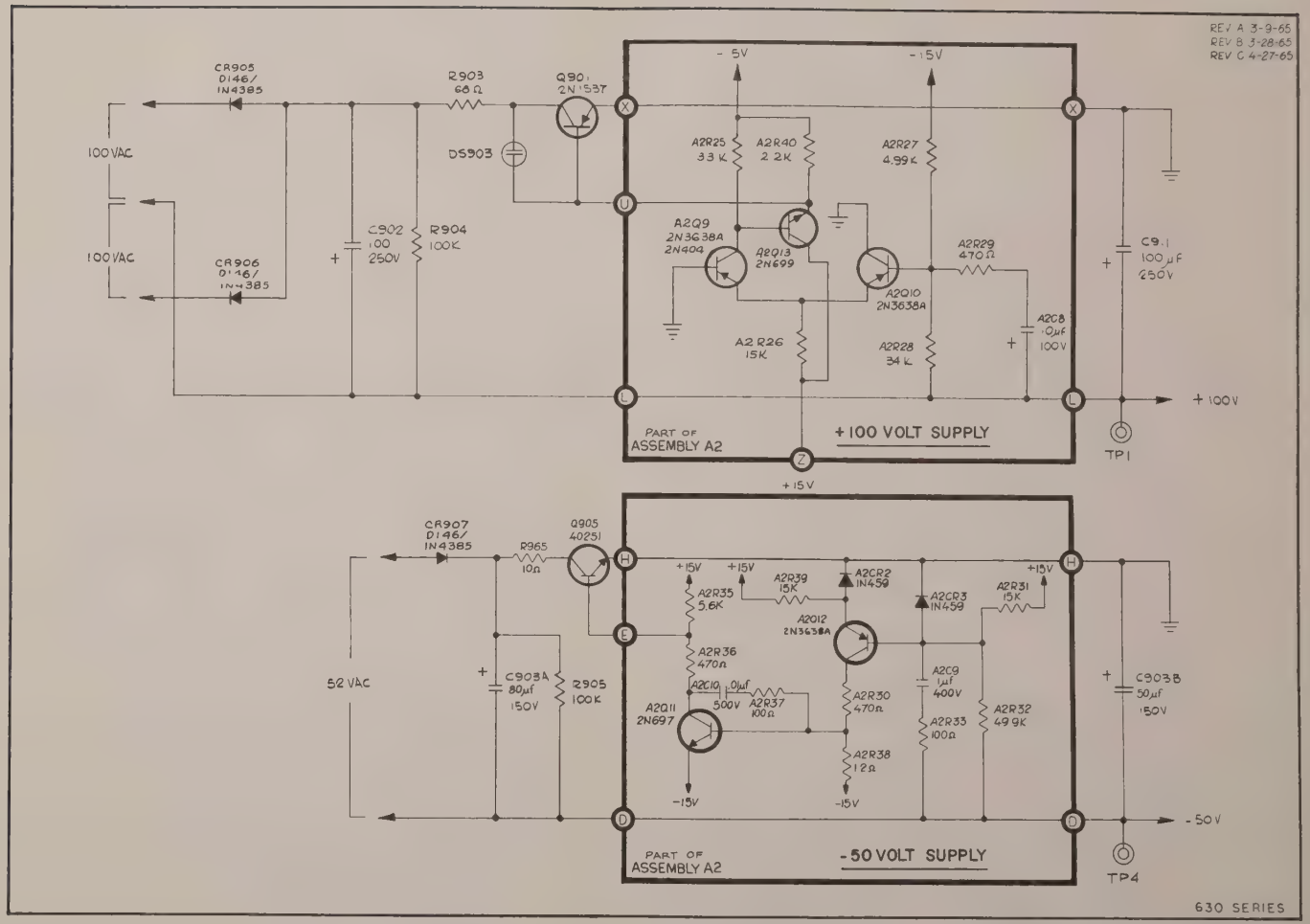
The power level of the backward wave oscillator tube is controlled by means of a feedback leveler. Rf energy from the output of the tube is sampled by means of a directional coupler and then fed into a bolometer mount. The bolometer consists of a pair of barretters, one of which is sensitive to the rf energy. Rf energy incident upon the barretter causes a change in temperature which changes its resistance. A constant current is applied to the barretter converting the resistance change to a voltage change. A reference barretter, in the same mount, is not exposed to the rf energy, but is subject to the same ambient temperature variations because it is thermally in contact but electrically isolated from the other barretter. The output of the barretters is connected to the input of a differential amplifier which response to rf variations but not to ambient temperature changes. When the reference barretter is independently heated by a high frequency signal, supplied by a controllable oscillator, a voltage difference will appear at the input of the differential amplifier. This voltage is then amplified and applied, through a feedback system, to the transfer oscillator, resulting in an increase in the amplitude of oscillation of the tube and more energy is supplied to the rf sensitive barretter. Since the open loop gain of the system is large the rf microwave energy is controlled to match the energy supplied to the reference barretter. Hence, any modulation applied to the reference barretter must also be reproduced in the rf due to the feedback action of the leveler. Consequently, the modulation is actually applied to the controllable oscillator which provides power to the reference barretter. The controllable oscillator is feedback controlled and operates at approximately 10 megacycles.

Modulation of the controllable oscillator can be accomplished by either an external source or an internally generated square wave. The square wave voltage is produced by two transistors acting as a multivibrator. The frequency of the square wave is varied by a front panel control over a range of 800 to 1200 cps. There are two other controlling inputs to the oscillator; the input from the markers so they will appear on the rf and an input from the retrace blanking circuit to cut off the oscillator during retrace.

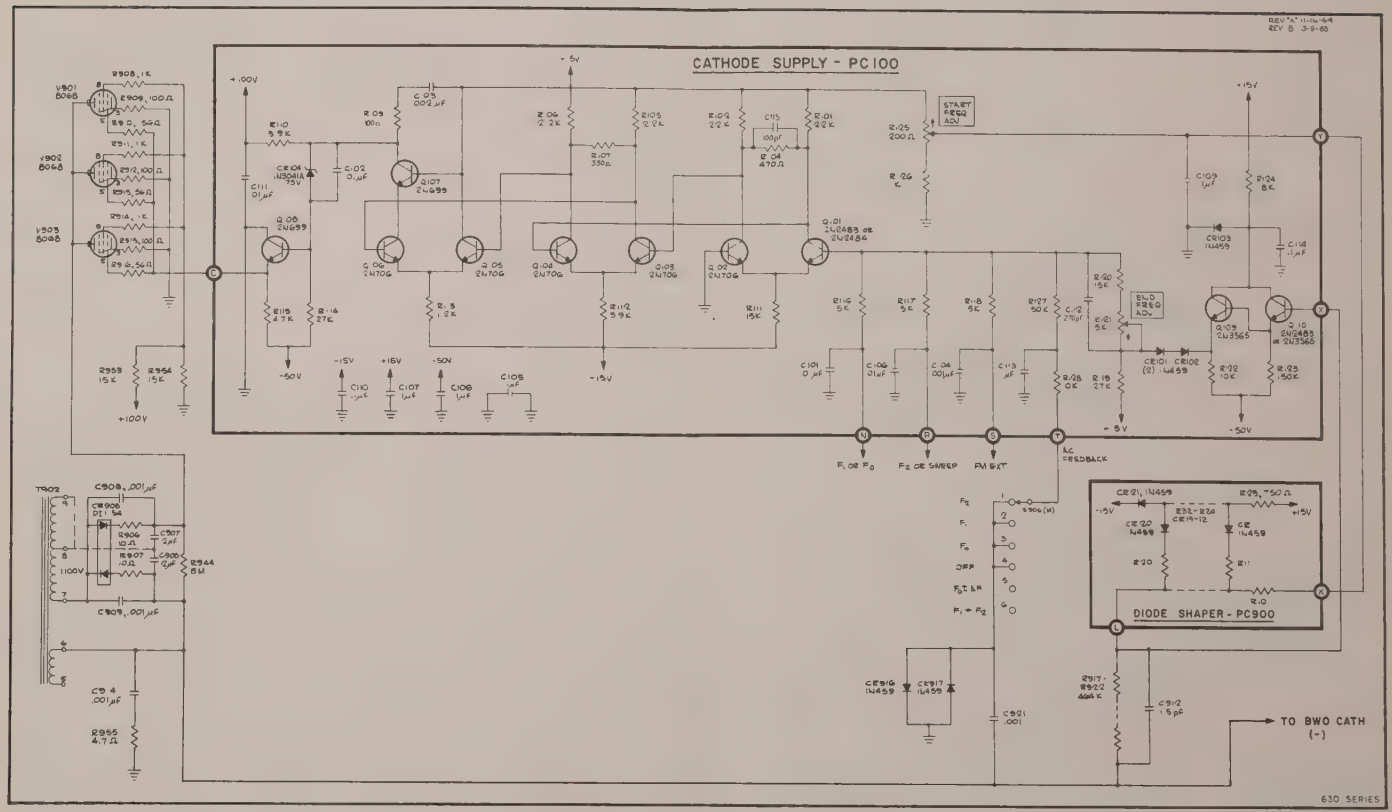
It is also possible to operate the Model 630 in the unleveled mode. In this condition the circuits are unbalanced in such a way that zero bias is applied to the grid of the backward wave oscillator tube and maximum power output is produced.



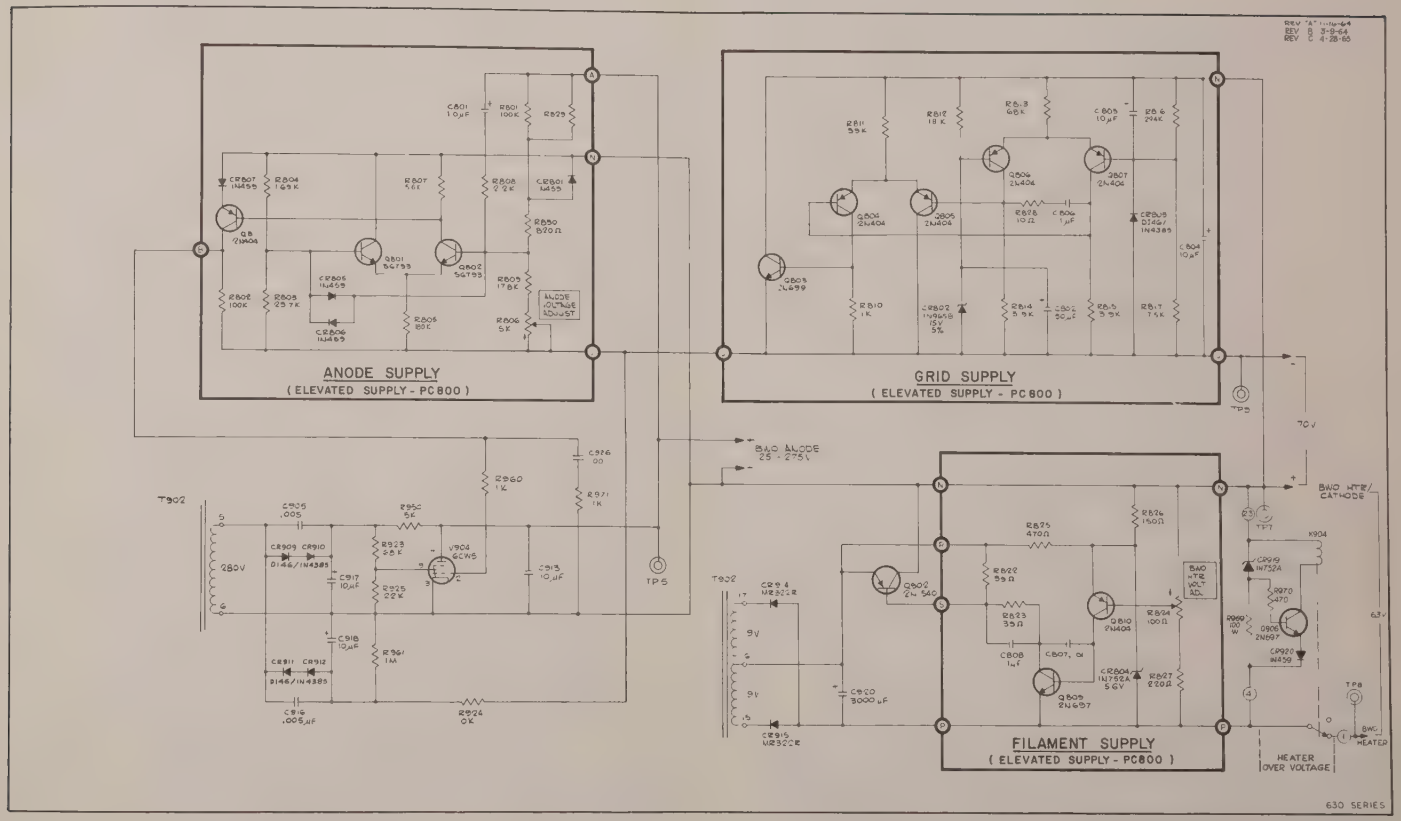
+15, -15 VOLT SUPPLIES
FIGURE 3-3



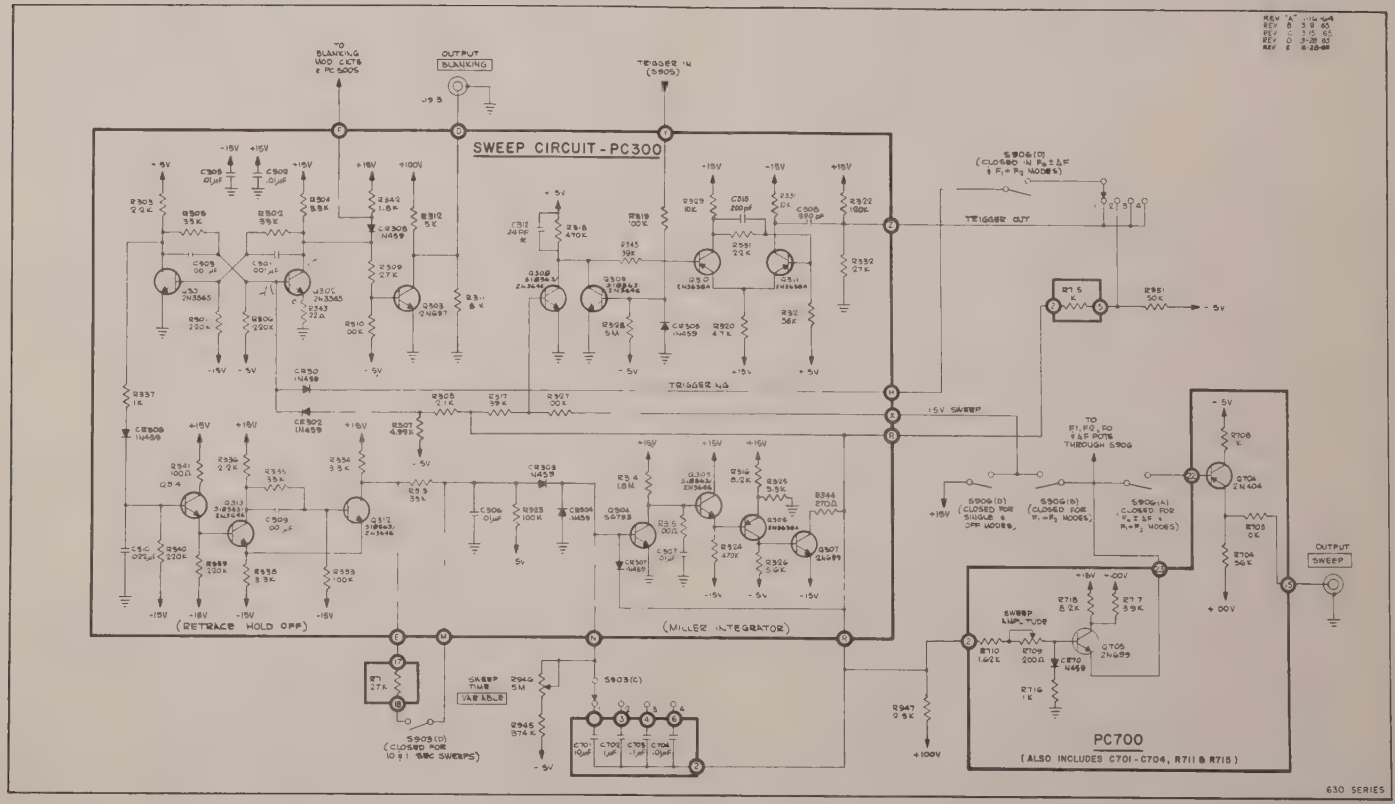
+100 & -50 VOLT SUPPLIES
FIGURE 3-4



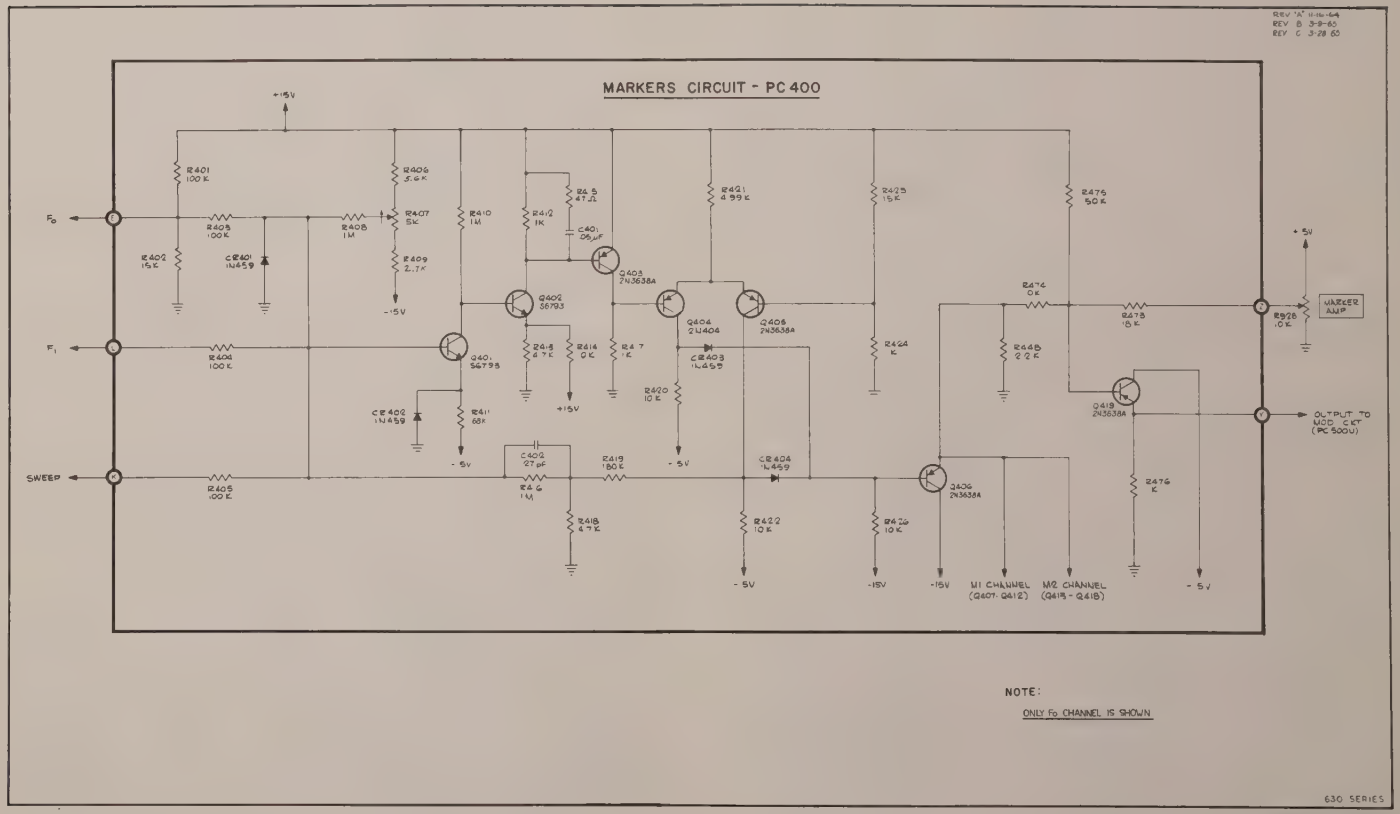
CATHODE SUPPLY
FIGURE 3-5



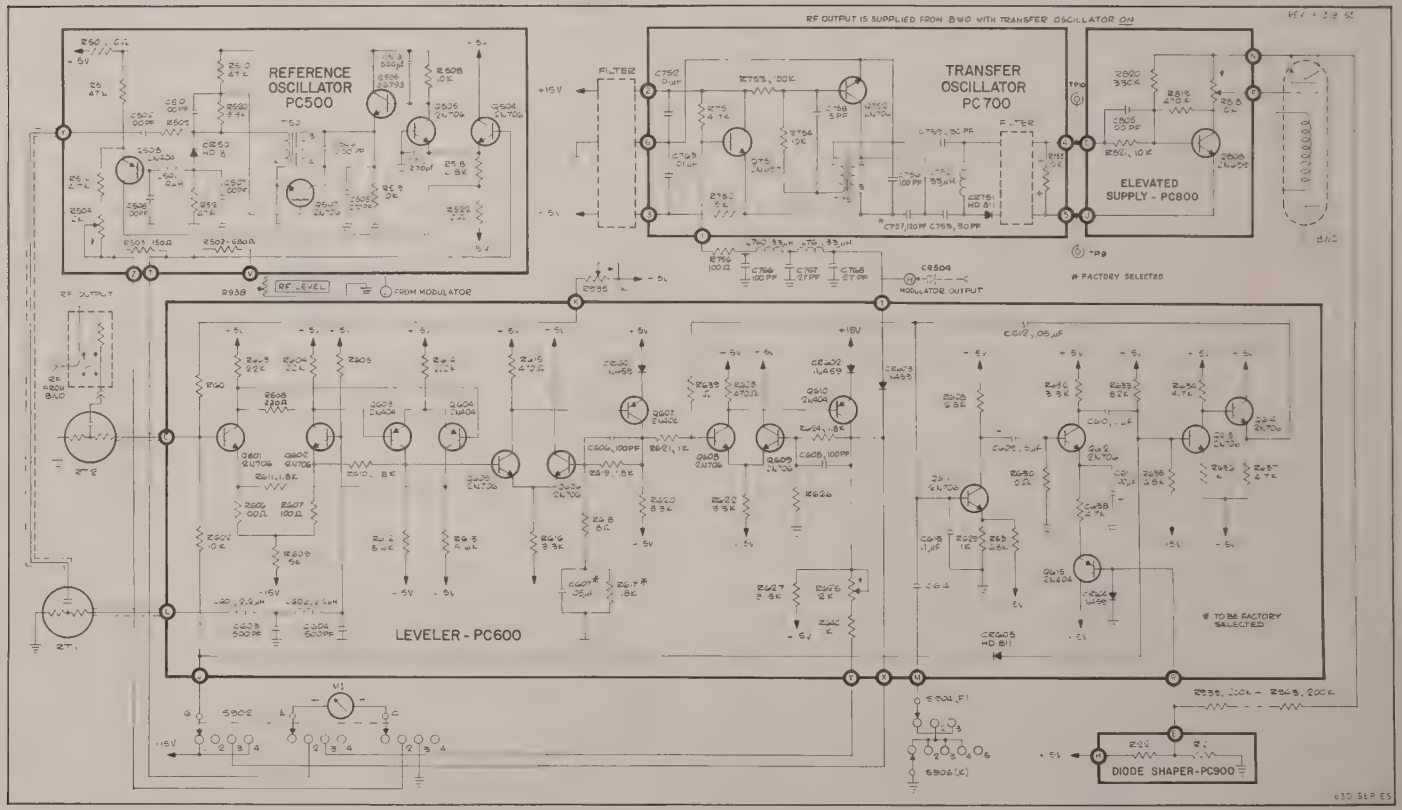
ANODE , GRID & FILAMENT SUPPLIES
FIGURE 3-6



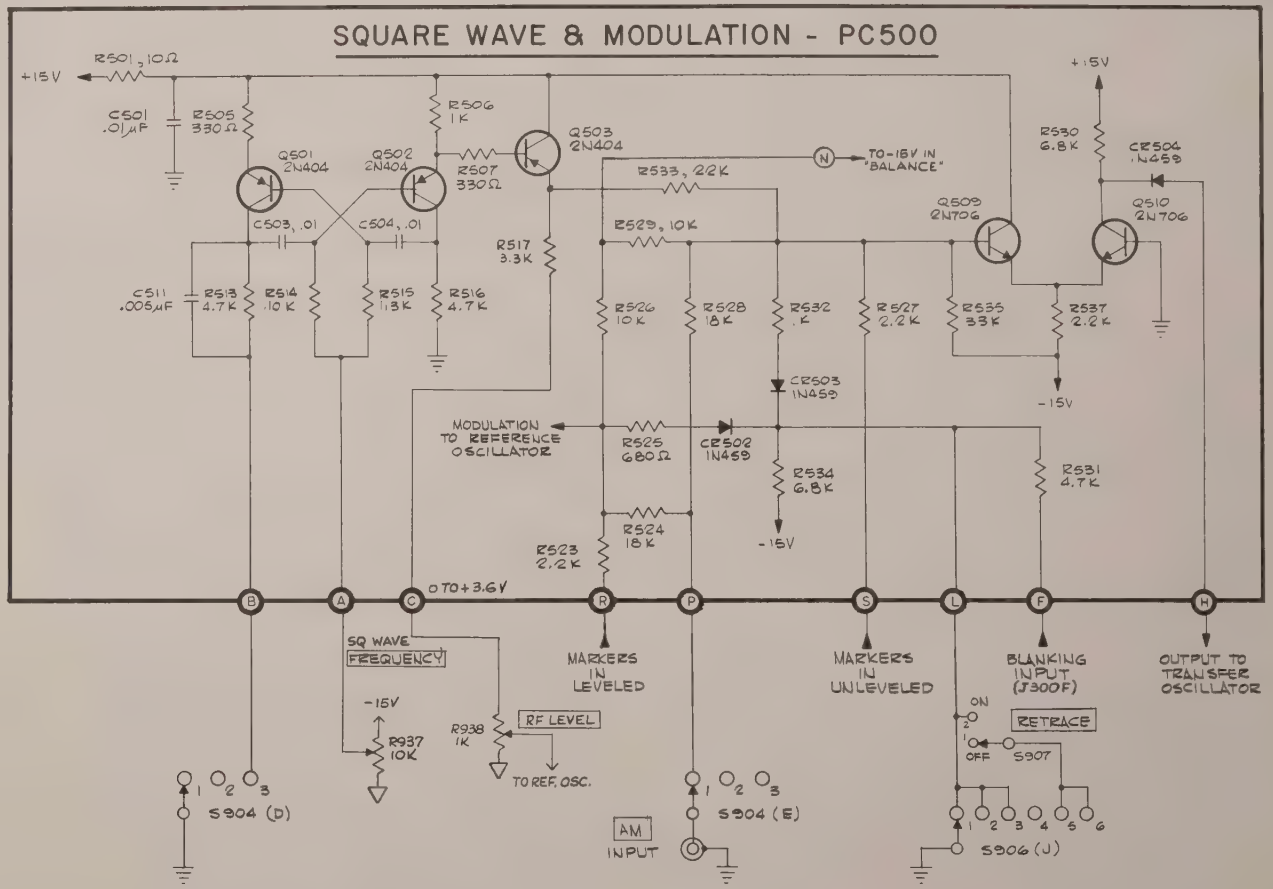
SWEEP CIRCUIT
FIGURE 3-7



MARKERS CIRCUIT
FIGURE 3-8



REFERENCE & TRANSFER OSCILLATORS
AND LEVELER CIRCUIT
FIGURE 3-9



SQUARE WAVE & MODULATION
FIGURE 3-10

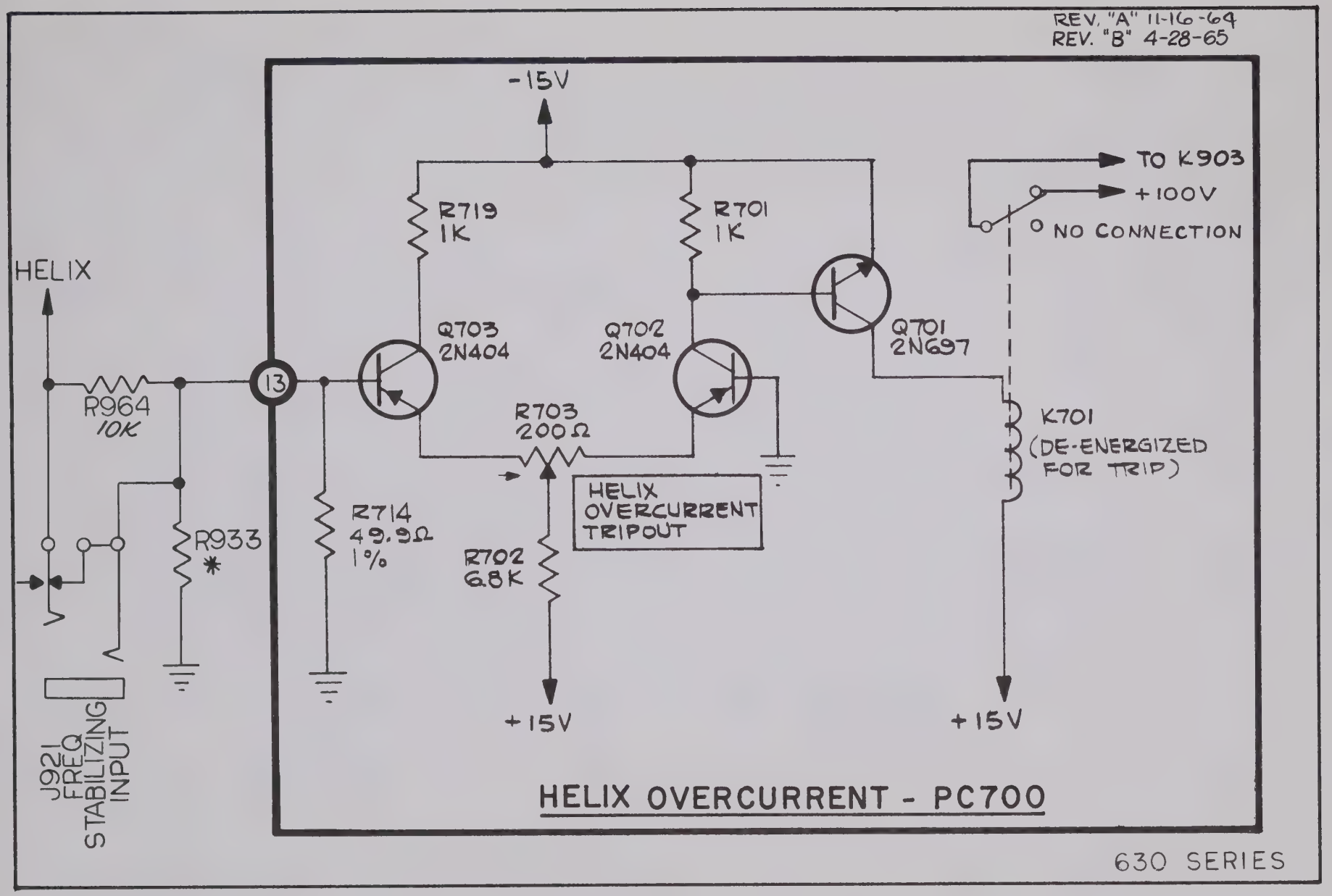
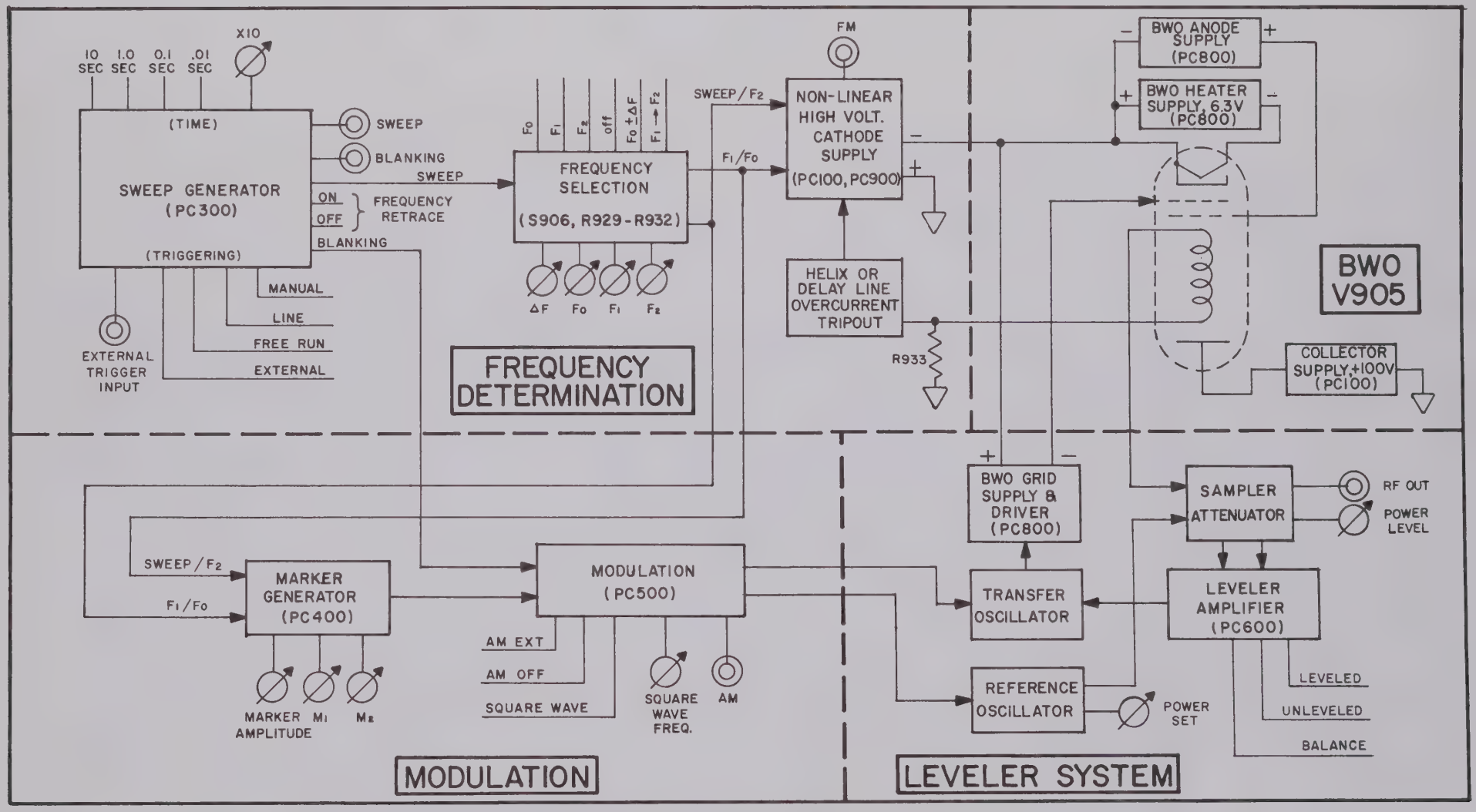

REV. "A" 11-16-64
REV. "B" 4-28-65
-15V
TO K903
+100V
NO CONNECTION
R719
1K
R701
1K
HELIX
Q703
2N404
Q702
2N404
Q701
2N697
13
R964
10K
R703
200Ω
K701
(DE-ENERGIZED
FOR TRIP)
HELIX
OVERCURRENT
TRIPOUT
R714
49.9Ω
1%
R933
*
R702
6.8K
+15V
+15V
J921
FREQ
STABILIZING
INPUT
HELIX OVERCURRENT - PC700
630 SERIES

FIGURE 3-11



MODEL 630 SWEEP SIGNAL GENERATOR
BLOCK DIAGRAM
FIGURE 3-12

SECTION 4 - MAINTENANCE

CAUTION: High voltages exist in this instrument. Observe caution when calibrating or performing maintenance on the instrument. When the back or top cover plates are removed, the high voltage interlock turns OFF the HIGH VOLTAGE.

4.1 TROUBLE SHOOTING

If trouble is encountered, the following procedures may help isolate the cause.

NOTE: Before attempting to trouble shoot the instrument, make sure that an apparent trouble is actually due to a malfunction within the instrument and not to improper control settings or external causes.

4.1.1 GENERAL

1. Check all fuses. Replace with type 3AB, 250 volt and current value specified.

2. If power can be applied without blowing fuses, check the four low voltage power supplies; +15, -15, +100 and -50 and the elevated supplies; anode, grid and filament.

NOTE: A floating voltmeter must be used to check the elevated supplies.

If a power supply is at fault, the cause may be due to a defective transistor or tube, or one of the circuits using the supply may be excessively loading it due to a defective or grounded component.

4.1.2 NO HIGH VOLTAGE WITH HIGH VOLTAGE INDICATOR LIGHT OFF

1. Check to see if K901 (-9, 8) to (-3, 4) closes after 60 seconds.

2. Check the thermal time delay relay. Check for 6.3 volts at XK901-1, -6.

3. If K902 does not close, check the +100 volt supply.

4. See if the jumper at TB901-1, -2 is in place.

5. Check to see if K903 is de-energized. If not, check the HELIX TRIP-OUT circuit as follows;

   a. Set METER control to BWO I

   b. Set rear switch, S913 to HELIX/ DELAY LINE

   c. Set FREQUENCY mode selector to SINGLE; F_0

   d. POWER switch to ON

After approximately 60 seconds, the high voltage should momentarily appear. Note the meter reading while the high voltage is present. If it is equal to or greater than the value given in Chart #1, Section 5, the backward wave oscillator tube and its associated voltages should be checked. If the relay trips out at a meter reading which is appreciably lower than the value indicated, then the setting of the trip out circuit should be checked according to the procedures of the Overcurrent Trip-out Adjustment, Paragraph 4.4.3.

4.1.3 NO HIGH VOLTAGE WITH HIGH VOLTAGE INDICATOR LIGHT ON

1. Check the output of T902 (CAUTION: HIGH VOLTAGE - 1100 volts rms at terminals 7 and 9).

2. Check the rectifier and the filter circuit.

3. Check series tubes V901, V902 and V903.

4. Trouble shoot the cathode supply board, J900.

4.1.4 NO RF UNDER ANY CONDITION

1. With the high voltage OFF, check the backward wave oscillator heater voltage between (+) TP7 and (-) TP8. Value should be approximately 6.3 volts. If not, try to adjust to 6.3 by using R824 (see Figure 4-4).

   If value cannot be obtained, trouble shoot the filament supply.

2. With the unit OFF, disconnect P920 from J920. Measure the resistance at Pins C and B of P920. The value should be less than 20 ohms. The specific value will depend upon the tube. If the circuit shows open, the filament of the backward wave oscillator tube is open and the tube should be replaced. If the filament is not open, reconnect P920 and J920.

3. With the MODULATION control at AM OFF, the FREQUENCY mode selector at SINGLE; F_0, the METER control at BWO I and the F_0 FREQUENCY control to 0 on the logging scale; measure the cathode voltage between (+) TP0 and (-) TP7. Compare with the tube data sheet in the envelope in back of the manual. Move F_0 control to 100 on logging scale. Again, check with sheet. If values do not check out, trouble shoot high voltage supply.

4. With the HIGH VOLTAGE ON, measure the anode voltage between (+) TP5 and (-) TP7 (CAUTION: HIGH VOLTAGE). The value should be approximately the value indicated on the tube data sheet located in the envelope. If not, try to adjust to correct value by using the ANODE ADJUST R806 (see Figure 4-4).

CAUTION: Do not advance the ANODE ADJUST beyond the point where collector or helix current is greater than the value specified by the tube manufacturer. See envelope in back of manual.

5. Measure the voltage between (-) TP0 and (+) TP11. The value should be between 8 and 12 volts. If not, trouble shoot the modulation circuit (PC500) and the switching in the modulation circuit (located on the rear of the front panel).

6. Measure the voltage between (+) TP9 and (-) TP10 (CAUTION: HIGH VOLTAGE). The value should be between 4 and 8 volts. If not, trouble shoot the transfer oscillator circuit.

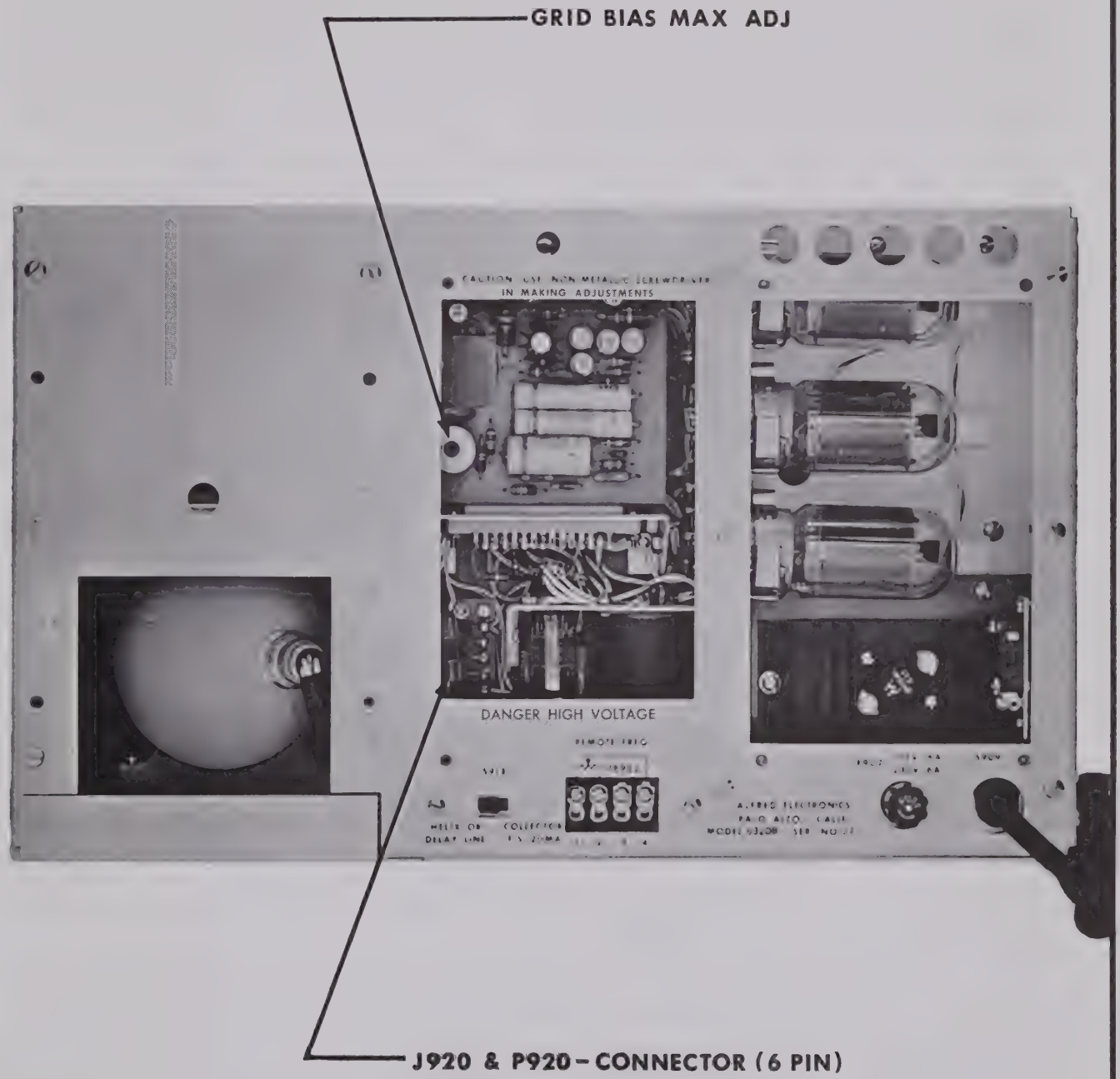
7. With METER control at BWO I, FREQUENCY mode selector to SINGLE; F_0, and the MODULATION control at AM OFF, measure the grid voltage between (+) TP7 and (-) TP6. The value should be less than 2 volts. If not, check the grid supply and the grid driver stage on PC Board 800 (Elevated Supply).

8. If all supplies and voltages check out and there is no indication of helix or collector current on the meter, replace the backward wave oscillator.

4.1.5 RF NOT LEVELED OR NO RF OUTPUT WHEN METER CONTROL IS IN LEVELED POSITION

NOTE: When the METER control is in the LEVELED position and the power of the unit varies less than the specified value for your instrument (see Specifications, Page 1-1) as indicated on a suitable power meter over the full frequency range, the rf is leveled. If the power varies more than the specified value, perform the following:

1. Set METER control to BALANCE. Check to see if red line can be obtained by using the front panel screwdriver adjust. If not, check the resistance of the barretters. See Figure 4-6. The value should be between 100 and


GRID BIAS MAX ADJ
CAUTION USE NON METALLIC SCREWDRIVER
IN MAKING ADJUSTMENTS
DANGER HIGH VOLTAGE
J920 & P920 – CONNECTOR (6 PIN)

REAR VIEW

FIGURE 4-1

200 ohms, but not open circuit.

CAUTION: Use ohmmeter whose current does not exceed 10 milliamperes.

2. If barretters are good, trouble shoot the leveler circuit, PC 600.

3. If the leveler circuit checks out, set the METER control to RF LEVELED.

   The FREQUENCY mode selector to SINGLE; F_0.

   The MODULATION control to AM OFF.

   Check to see if the concentric POWER SET control can give a meter reading of 1 to at least 7. If not, trouble shoot the reference oscillator, PC 500.

4. If leveling occurs over most of the band but not over all of the band, check the rf output in the UNLEVELED condition while sweeping the entire frequency range. If the output, in any part of the band, is less than the minimum specified for your instrument in the LEVELED condition (see specifications, Page 1-1) the anode voltage can be increased until the required power is available by adjusting R806 (ANODE ADJUST).

CAUTION: Do not advance the ANODE ADJUST beyond the point where collector or helix current is greater than the value specified by the tube manufacturer. See envelope in back of manual.

4.1.6 UNIT UNABLE TO SWEEP

1. Set FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$.

2. Set SWEEP; TIME control to .01 seconds, calibrated.

3. Set SWEEP; TRIGGER control to FREE RUN.

4. Check diodes and transistors on PC Board 300.

5. Check the waveforms and compare to those of Figure 4-2.

4.2 TEST POINTS

See Figures 4-3 and 4-4

NOTE: TP0 through TP4 located left side of instrument. TP5 through TP10 located top rear insulated board.

TP0 chassis ground.

TP0 to TP1, +100 volts (low voltage supply; 97 volts to 103 volts).

TP0 to TP2, +15 volts (low voltage supply; +15 volts).

TP0 to TP3, -15 volts (low voltage supply; 14.9 volts to 15.1 volts).

TP0 to TP4, -50 volts (low voltage supply; 45 volts to 55 volts).

TP7 to TP5, backward wave oscillator anode voltage (see envelope - Addendum A for value).

TP7 to TP6, backward wave oscillator grid. (See envelope - Addendum A for value.)

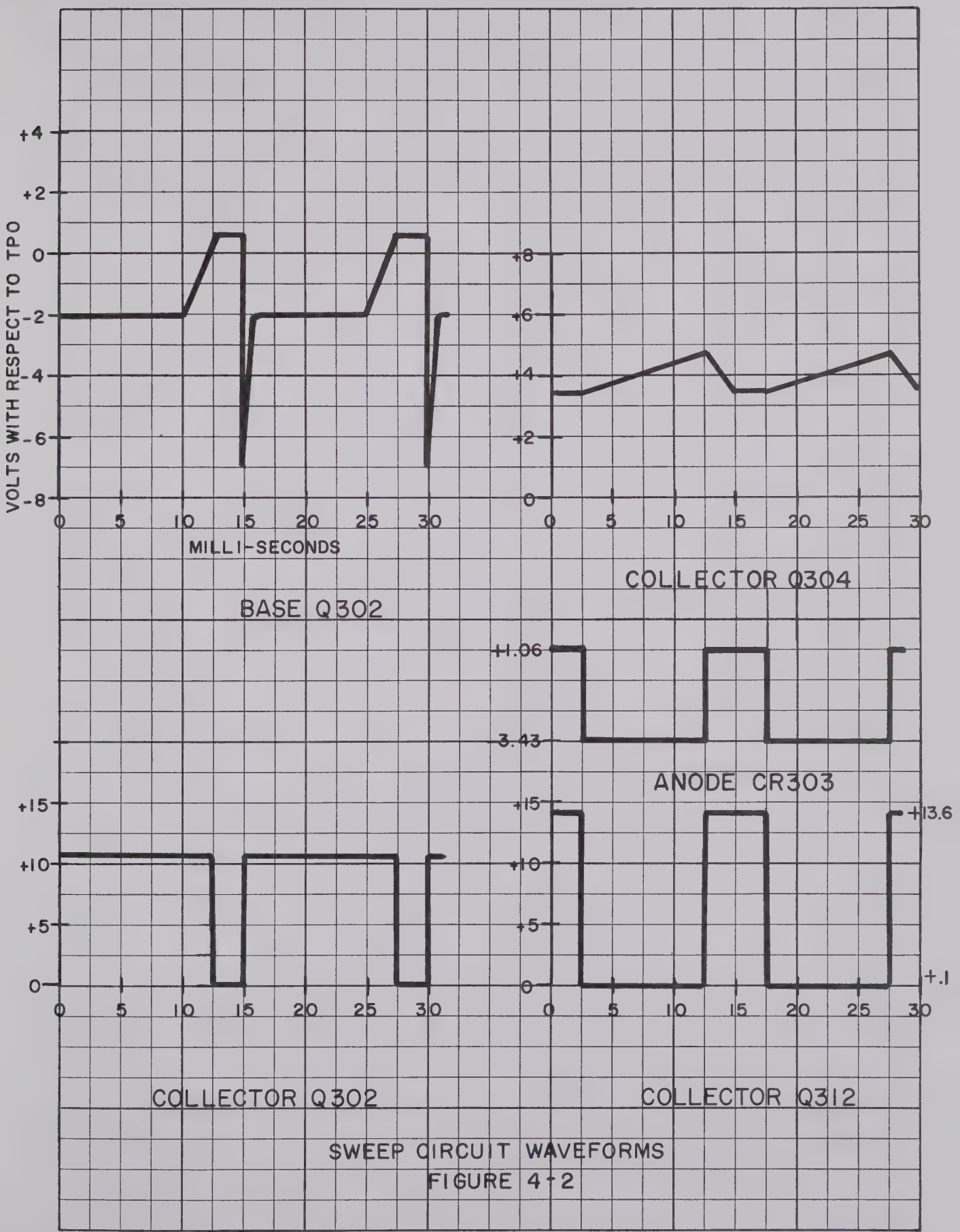
TP7 to TP9, backward wave oscillator grid supply (-60 volts to -70 volts).

TP0 to TP7, backward wave oscillator cathode.

TP7 to TP8, backward wave oscillator heater (6.2 volts to 6.4 volts).

TP10 to TP9, output of transfer oscillator.

TP0 to TP11, input to transfer oscillator. (TP11



SWEEP CIRCUIT WAVEFORMS
FIGURE 4-2

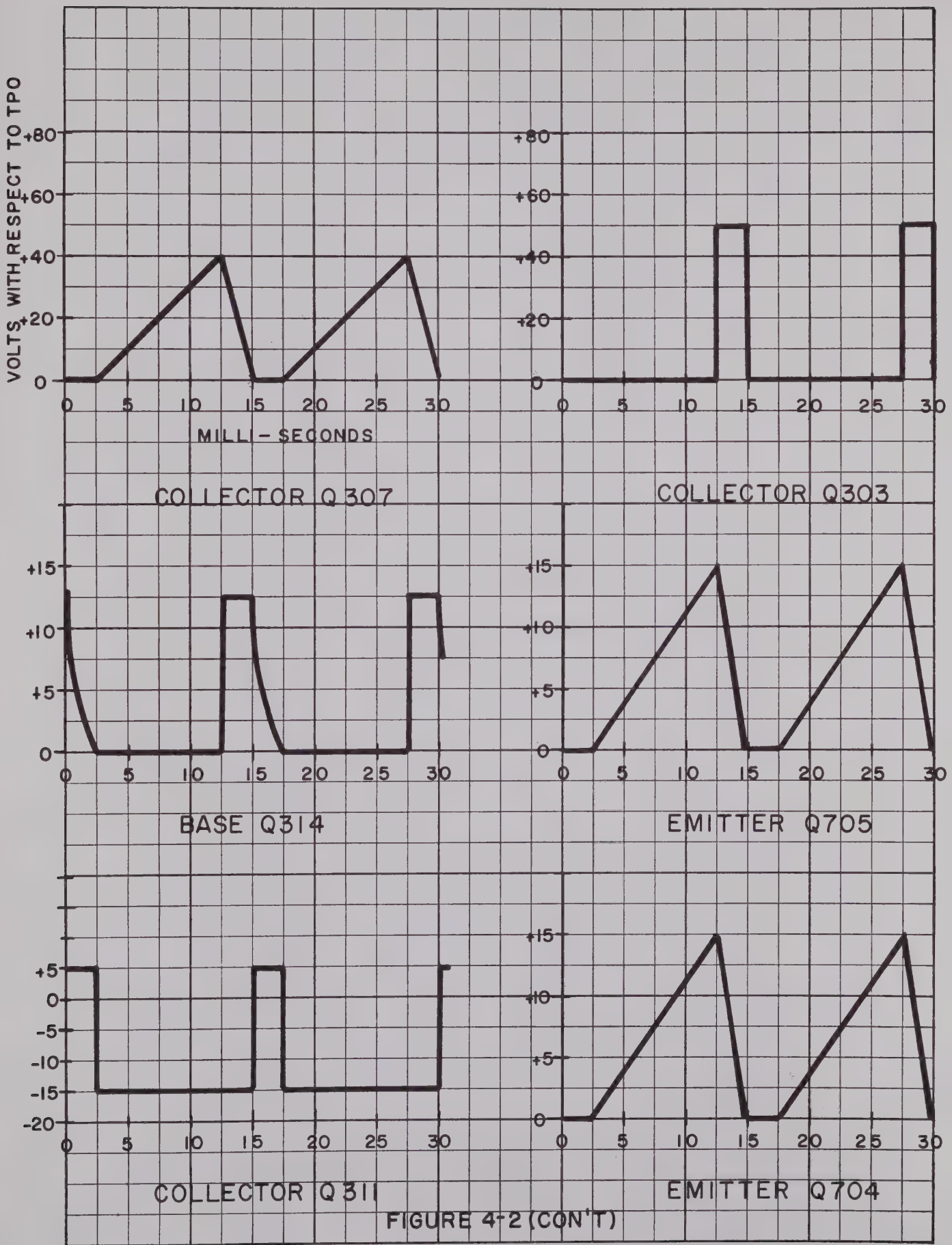


FIGURE 4-2 (CON'T)

Located on main chassis near C903.

4.3 CALIBRATION

4.3.1 FREQUENCY CALIBRATION

1. Turn POWER switch to ON with an appropriate rf wavemeter, crystal detector and oscilloscope connected to the RF OUTPUT of the unit.

2. Check BALANCE (red line). Then set METER control to RF LEVELED.

3. Set FREQUENCY mode selector to SWEEP; $F_0 \pm \Delta F$.

4. Set F_0 FREQUENCY indicator to the lowest frequency value of the instrument (0 on the logging scale).

5. Set the rf wavemeter to this frequency.

6. Adjust R125 (START FREQUENCY ADJUST) so the wavemeter pip appears in the center of the oscilloscope face. See Figure 4-3.

   NOTE: ΔF AMPLITUDE control should be full on (clockwise).

7. Reduce the ΔF AMPLITUDE control while adjusting R125 so the pip remains in the center.

8. Move F_0 FREQUENCY indicator to the high frequency value of the instrument (100 on logging scale).

9. Set the rf wavemeter to this frequency.

10. Adjust R121 (END FREQUENCY ADJUST) so the wavemeter pip appears in the center of scope face.

NOTE: ΔF AMPLITUDE control should be full on (clockwise).

11. Reduce the ΔF AMPLITUDE control while adjusting R121 so the pip remains in the center of the oscilloscope face.

Repeat Steps 1 through 11 until both ends are on frequency. Repeating the steps is necessary because of the interaction of R125 and R121.

4.3.2 WIDE SWEEP CALIBRATION

See Figure 4-4

1. FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$

2. FREQUENCY control F_1 to 0 on logging scale.

3. FREQUENCY control F_2 to 100 on logging scale.

4. Adjust frequency meter to frequency of F_2 setting.

5. Adjust R709 until pip is exactly at end of sweep as seen on the oscilloscope.

4.3.3 RF POWER LEVEL CALIBRATION

See Figure 4-3.

1. Remove the left handle side.

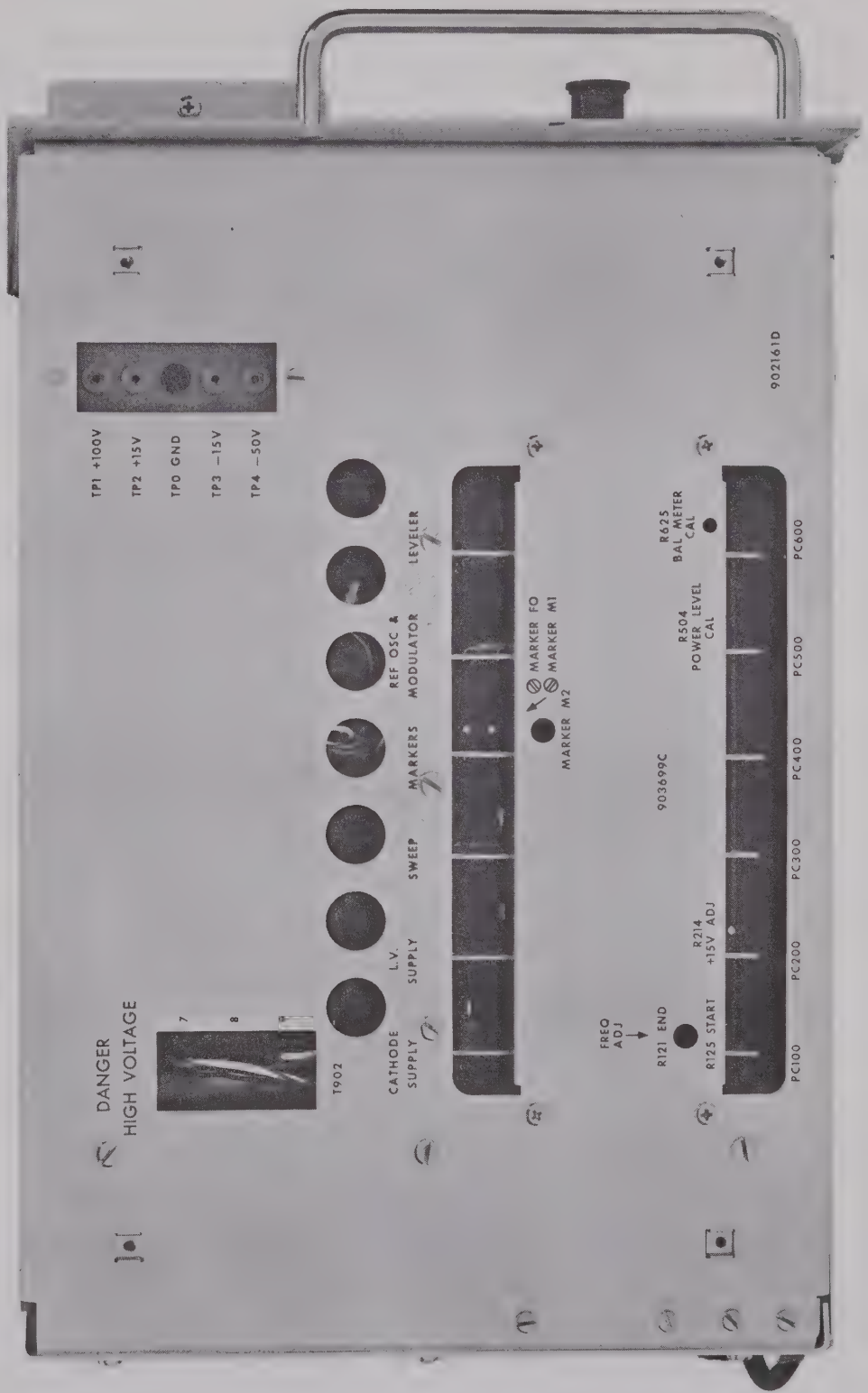
2. Turn POWER switch to ON.

3. Connect a suitable rf power meter to the RF OUTPUT jack.

4. Set the POWER LEVEL to +10 dbm using the attenuator control on 630D models. (No modulation and single frequency.)

5. Set the METER control to BALANCE and adjust meter to red line by using the adjacent screw driver adjust.

6. After adjustment, set METER control to RF



LEFT SIDE VIEW

FIGURE 4-3

LEVELED and adjust the power level to red line on the meter by using the concentric POWER SET control.

7. Measure the output power with the rf power meter.

8. Adjust R504 (POWER LEVEL CALIBRATION) until +10 dbm is indicated on the rf power meter while keeping the meter red lined. This will require the operator to continuously adjust the POWER SET control for red line as any adjustment of R504 affects the meter reading.

9. Check the power level over the entire frequency band to see if it is within ± 1/2 db of +10 dbm.

10. Replace the left handle side.

4.3.4 MARKER CALIBRATION

1. Set METER control to RF LEVELED.

2. Set FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$.

3. Set F_1 FREQUENCY control to 0 on the logging scale.

4. Set F_2 FREQUENCY control to 10 on the logging scale.

5. Set SWEEP; TIME to .1 seconds (calibrated).

6. Set SWEEP; TRIGGER to LINE.

7. Turn MARKER AMPLITUDE up as necessary.

8. Apply the sweep output of the unit to the horizontal deflection input of an oscilloscope.

9. With a suitable frequency meter and crystal detector in series with the output, display the output of the crystal detector on the oscilloscope.

10. Set the M_1 MARKER control to any frequency between 0 and 10 on the logging scale.

11. Set the frequency meter to this frequency.

12. Adjust R432 (MARKER M_1) until the wavemeter pip and the marker pip coincide.

13. Remove M_1 marker pip from the oscilloscope and set the M_2 MARKER control to the frequency of the frequency meter.

14. Adjust R455 (MARKER M_2) until the wavemeter pip and the marker pip coincide.

15. Remove M_2 marker pip from the oscilloscope and set F_0 FREQUENCY control to the frequency of the frequency meter.

16. Adjust R407 (MARKER F_0) until the two pips coincide.

4.4 INTERNAL ADJUSTMENTS

NOTE: Both the top and rear cover plates actuate safety interlock switches that prevent high voltage operation when removed.

4.4.1 +15 VOLT ADJUSTMENT

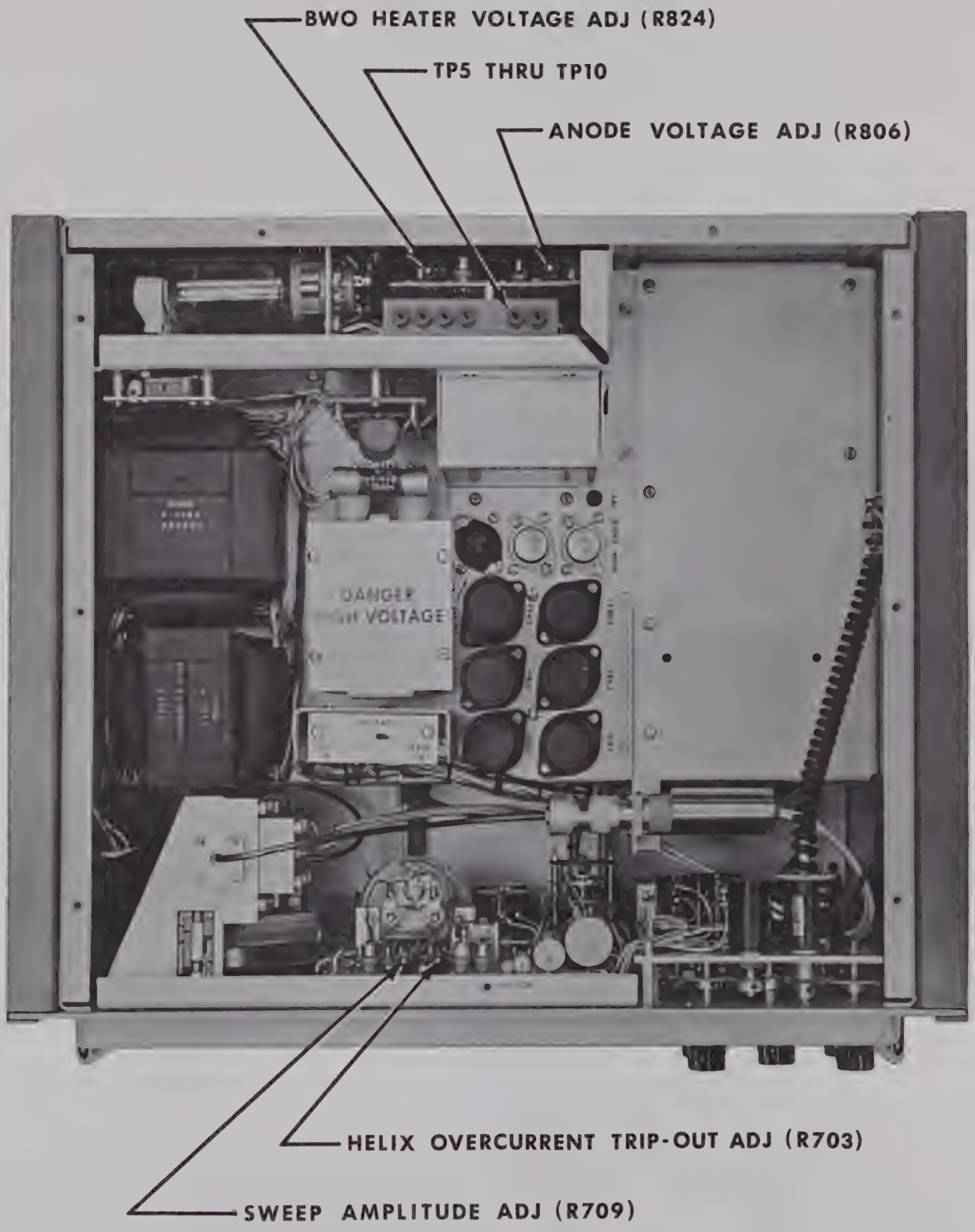
See Figure 4-3

1. Remove the left handle side cover plate.

2. Connect a 0.1% dc voltmeter between TP2 and TP0.

3. Adjust R214 (+15 VOLT ADJUST) for 15.00 volts.

4. This adjustment also affects the -15 volt, +100 and -50 volt supplies but the absolute value of these supplies is not critical.


BWO HEATER VOLTAGE ADJ (R824)
TP5 THRU TP10
ANODE VOLTAGE ADJ (R806)
HELIX OVERCURRENT TRIP-OUT ADJ (R703)
SWEEP AMPLITUDE ADJ (R709)

TOP VIEW

FIGURE 4-4

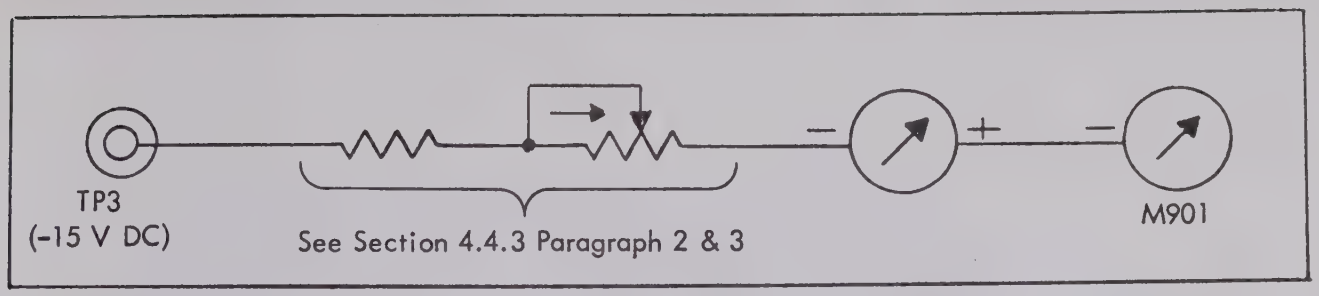


Figure 4-5

5. Replace the left handle side cover plate.

4.4.2 BALANCE METER ADJUSTMENT

See Figure 4-3

1. Remove the left handle side cover plate.
2. Set the F_1 and F_2 FREQUENCY controls to their extreme positions (0 and 100 on the logging scale).
3. Set the FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$ (10 second sweep).
4. Set MODULATION control to SQUARE WAVE.
5. Set METER control to RF LEVELED.
6. Adjust the front panel BALANCE screw driver adjust so that good symmetry, good rise time and minimum overshoot of the square wave is obtained. This adjustment will be a compromise between symmetry, rise time and overshoot.
7. Set METER control to BALANCE.
8. Adjust R625 so that the meter reads red line.
9. Replace left handle side.

4.4.3 OVERCURRENT RELAY TRIP-OUT ADJUSTMENT

See Figure 4-4

Check Chart #1, Section 5 for the proper setting and full scale reading of meter M901 when switch S913 is in HELIX/DELAY LINE setting.

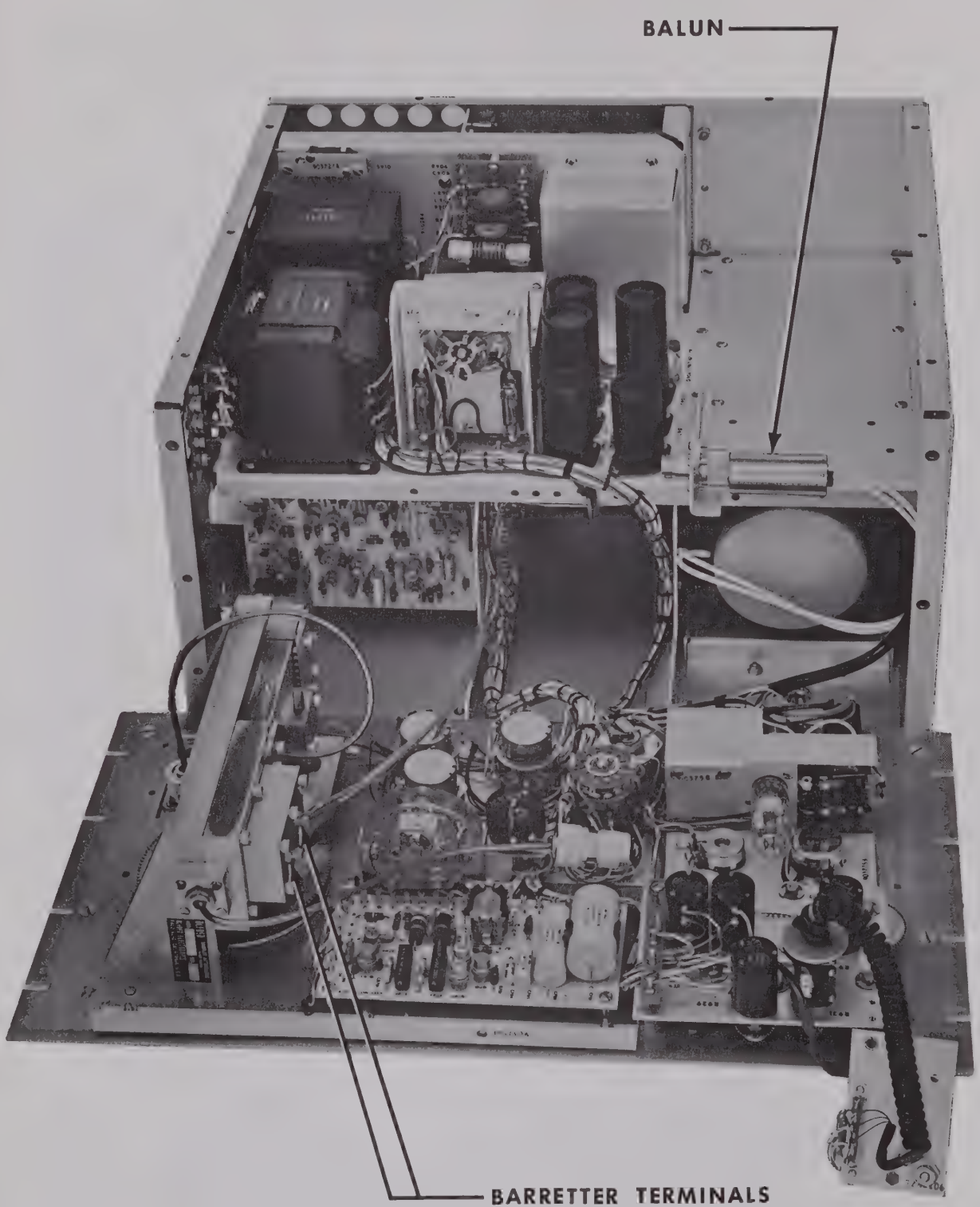
1. Remove the top cover.
2. Connect a 3 K ohm resistor, a 20 K ohm or greater potentiometer and a suitable current meter (5 ma) in series between TP3 (-15 v dc) and the negative terminal of M901. This set-up is for a full scale deflection of 5 ma.
3. For a full scale deflection of 50 ma, connect a 270 ohm resistor a 5 K ohm or greater potentiometer and a suitable current meter (50 ma) between TP3 (-15 v dc) and the negative terminal of M901. See Figure 4-5.
4. Turn POWER switch to ON but leave the HIGH VOLTAGE off by leaving the high voltage interlock open.
5. Set METER control to BWO I.
6. Set rear switch, S913, to HELIX/DELAY LINE.
7. Adjust the potentiometer by starting at a low value of current and gradually increase until the overcurrent relay K701 trips (de-energizes). Check current at which relay tripped. Adjust R703 so the relay trips at the current value indicated.

NOTE: Always proceed from a low current value by adjusting the potentiometer each time the trip-out point is checked.

4.4.4 BACKWARD WAVE OSCILLATOR HEATER ADJUSTMENT

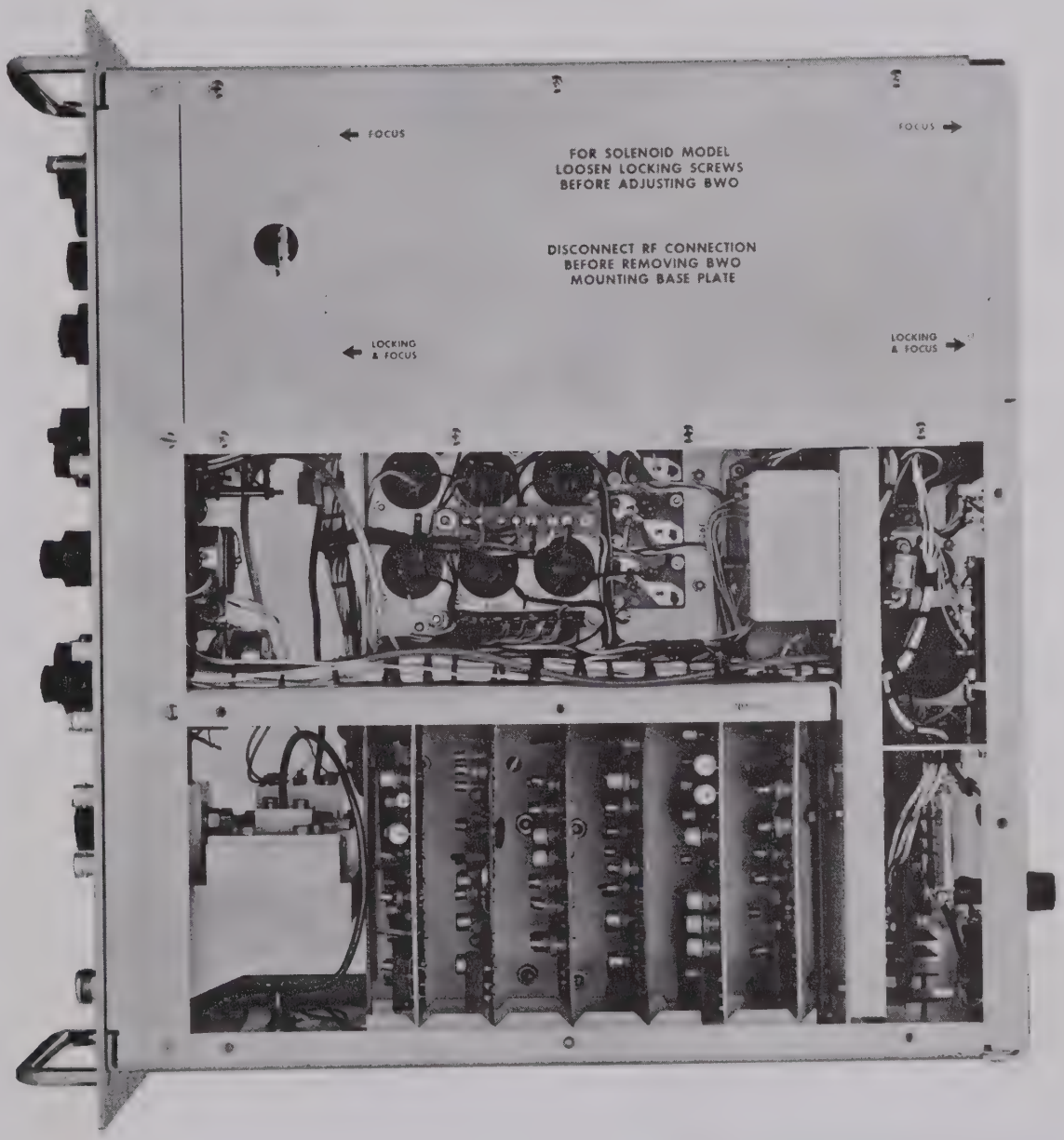
See Figure 4-4

1. Remove the top cover plate.
2. Set FREQUENCY mode selector to OFF.
3. Set F_0 FREQUENCY indicator to 0 on logging scale.
4. Set MODULATION control to AM OFF.
5. Set SWEEP; TRIGGER to FREE RUN.
6. Set SWEEP; TIME to .01 seconds.



FRONT VIEW (PANEL OPENED)

FIGURE 4-6



BOTTOM VIEW

FIGURE 4-7

7. Connect the positive lead of a dc voltmeter to TP7 and the negative lead to TP8.

8. With the instrument ON and the backward wave oscillator connected, adjust R824 to 6.3 volts dc. (This should be done at 115 volt line.)

9. Replace top cover plate.

4.4.5 BACKWARD WAVE OSCILLATOR GRID ADJUSTMENT

See Figure 4-1

Remove the rear cover plate.

1. FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$.

2. MODULATION control to SQUARE WAVE.

3. RETRACE control to OFF.

4. Adjust the GRID BIAS MAX. ADJUST (R818) so that the backward wave oscillator tube does not generate any rf during retrace and during the portion of the square wave where rf is off.

4.5 FRONT PANEL

The front panel may be dropped forward for access to components mounted inside. Remove the five control knobs and the dial mechanism cover. Remove the top cover plate and the right and left handle sides. Remove the coiled cable bracket (two screws). Remove any rf connections using caution. Remove the screws from the periphery of the front panel. The panel may now be turned forward on its face as all wiring comes out the bottom of the panel.

4.6 BACKWARD WAVE OSCILLATOR TUBE REPLACEMENT

See Figure 4-7 and Paragraph 4.8.

To replace the backward wave oscillator tube, remove the top cover plate.

1. Disconnect the rf connection from the tube to the unit.

NOTE: On units with baluns, disconnect the balun bracket from the unit before disconnecting the rf connector. Remove the balun from its bracket prior to Step 2. See Figure 4-6.

2. Turn unit over and remove the bottom cover plate.

3. Disconnect the one and six pin connector (P921 and P920).

NOTE: Some units only have the six pin connector (P920).

4. Remove the seven Phillips head screws from the periphery of the backward wave oscillator mounting base plate. See Figure 4-7.

5. Lift the whole tube assembly (tube and base plate) from the unit by using the finger hole provided.

6. Disconnect the tube from its base plates. Note position and screw hole alignment of old tube to aid in positioning of new tube.

7. Reverse procedure for installation.

4.7 FREQUENCY AND MARKER POTENTIOMETER REPLACEMENT

NOTE: The F_1 and F_2 potentiometers can be removed without dropping the front panel.

A. REPLACEMENT OF F_1 POTENTIOMETER

1. Remove top cover.

2. Unsolder leads from potentiometer terminals.

3. Rotate F_1 control knob full counterclockwise (CCW) to its lower mechanical stop. It is

important to remember the exact position of the indicator when the stop is reached, as this position must be maintained when the new potentiometer is installed.

4. Loosen both potentiometer shaft gear hub set screws.

CAUTION: Do not disrupt relative position of the F_2 potentiometer shaft gears. Make a pencil mark on the mounting plate and gear and realign before meshing the F_1 gear. If the F_2 gears are moved and not realigned, the mechanical stops will not be oriented and realignment must be performed according to the procedures of Section B, starting with Step 8.

5. Slide gear forward.

6. Remove potentiometer retaining nut and washer. While holding nut, washer and gear, withdraw potentiometer from mounting plate, noting orientation of potentiometer terminals.

7. Insert new potentiometer engaging washer, nut and gear. Tighten retaining nut remembering orientation of potentiometer terminals.

8. Position the F_1 potentiometer shaft full clockwise (CW) as viewed from the shaft end. This can best be accomplished by lightly tightening one gear set screw and while the gear is disengaged, finger turning the shaft full clockwise. Loosen the set screw.

9. Before engaging the gear check to see if the dial indicator is in the exact position as it was before and check to see if the F_2 gear lines up with its pencil mark.

10. Engage the F_1 potentiometer shaft gear and tighten both screws. NOTE: If the indicator is not in the exact position as noted in Step 3, do not position it by turning the F_1 dial cord drum. Instead, disengage the gear and reposition the indicator.

B. REPLACEMENT OF F_2 POTENTIOMETER

1. Remove the top cover, the five control knobs, and dial mechanism cover.

2. Unsolder the three leads from the potentiometer terminals. Remove the three small screws which hold the coiled wire bracket to the back of the potentiometer. The coiled wire is now free.

3. Rotate F_1 knob full counterclockwise (CCW) and the F_2 knob full clockwise (CW).

4. Loosen F_2 potentiometer gear hub set screws on both gear hubs.

5. Remove F_2 potentiometer by turning the potentiometer case in a clockwise direction as viewed from the shaft end.

6. Insert new potentiometer and tighten by turning in a counterclockwise direction.

7. Tighten set screws on gear hub closest to the mounting plate.

8. Disengage the idler gear connecting the F_1 potentiometer shaft gear to the F_2 potentiometer body gear.

9. Set the upper mechanical stop. This stop can be seen as a bent tooth on the gear on the F_2 potentiometer shaft and a small extension on the F_2 dial indicator shaft gear. The stop must be set below the center line of the F_2 dial indicator gear and the F_2 potentiometer gear as the F_2 knob turns clockwise.

   It may take a few attempts but no difficulty should be encountered.

10. Tighten the potentiometer shaft gear set screws.

11. Rotate the F_2 knob counterclockwise until the F_2 indicator is approximately 1/64" from the

F_1 indicator. Now, while holding the F_2 knob so as to maintain the 1/64" distance, rotate the entire F_2 potentiometer counterclockwise (CCW) until the mechanical stop is felt. If the indicators touch because the F_2 knob was allowed to turn after the stop was reached a slight clockwise turn on the F_2 knob will separate them.

12. Very carefully engage the idler gear between the F_1 potentiometer shaft gear and the F_2 potentiometer body gear (the one closest to the mounting plate) and tighten set screws.

    The lower and upper mechanical stops are now set. A gap should be maintained between indicators over the entire distance of the dial. Adjustments should be made beginning with Step 8 if gap is not maintained.

13. After the stops have been set, run the F_2 indicator full clockwise (CW) and the F_1 indicator to approximately 50 on the logging scale.

14. Remove the three screws from the back of the F_2 potentiometer.

CAUTION: Do not let the back of the potentiometer come off.

15. Secure the coiled wire bracket to the back of the potentiometer, and solder the three leads to the potentiometer terminals.

C. REPLACEMENT OF M_2 POTENTIOMETER

NOTE: Removal of the M_1, M_2 or F_0 potentiometer, requires dropping the front panel forward.

Remove the top cover, the right and left handle sides, the five control knobs and the dial mechanism cover. Remove the screws from the periphery of the front panel. Remove the screws which hold the coiled cable to the side of the instrument. Remove any applicable rf connections.

Drop front panel forward.

1. Unsolder the wires to potentiometer terminals.
2. Turn the M_2 and M_1 knobs full counterclockwise (CCW).
3. Remove retaining ring and thrust washer from the M_2 knob shaft.
4. Loosen the two set screws on the M_2 knob shaft gear hub.
5. Loosen the M_2 dial cord hub and press M_2 knob shaft about halfway out.
6. Loosen potentiometer shaft gear hub set screws.
7. Remove potentiometer retaining nut and washer and remove M_2 potentiometer remembering orientation of potentiometer terminals.
8. Position idler gear (with planetary gear) and new potentiometer shaft full clockwise (CW) as viewed from the front panel.
9. Insert new potentiometer and tighten retaining nut remembering potentiometer orientation.
10. Engage potentiometer shaft gear and tighten set screws. Make sure the potentiometer shaft is full clockwise (CW).
11. Press M_2 knob shaft into place and replace thrust washer and retaining ring.
12. Engage M_2 knob shaft gear with idler gear and potentiometer shaft gear.
13. Tighten set screws on M_2 knob shaft gear.
14. Rotate M_2 knob fully counterclockwise (CCW).
15. Rotate M_2 dial cord CCW until dial indicators are approximately 1/64" apart.

16. Tighten M_2 dial cord drum set screw.

D. REPLACEMENT OF THE M_1 POTENTIOMETER

1. Remove the Helix Overcurrent PC Board assembly. This will permit a wrench to be inserted from the left side of the gear assembly as viewed from the front of the unit.

2. Position M_1 and M_2 CONTROL knobs full CCW. Note position of indicators.

3. Loosen the M_1 potentiometer shaft gear hub set screws.

4. Remove M_1 potentiometer retaining nut and withdraw M_1 potentiometer, remembering orientation of potentiometer terminals.

5. Insert new potentiometer. Tighten retaining nut.

6. Replace M_1 potentiometer shaft gear making sure that the M_1 indicator is in previous position and the M_1 potentiometer shaft is full clockwise (CW).

7. Tighten set screws on potentiometer shaft gear.

8. Replace Helix Overcurrent PC Board.

9. Resolder leads.

E. REPLACEMENT OF THE F_0 POTENTIOMETER

1. Rotate the F_1 , F_0 and F_2 control knobs full counterclockwise (CCW).

2. Unsolder the leads to the F_0 potentiometer terminals.

3. Remove the F_1 knob shaft retaining ring and thrust washer.

4. Loosen the F_1 dial cord drum set screws remembering the exact position of F_1 indicator.

5. Move F_1 knob shaft forward disengaging F_1 knob shaft gear. Loosen F_1 knob shaft gear hub set screws.

6. Slide F_1 knob shaft forward until inner locking ring bottoms on F_1 knob shaft gear.

7. Loosen set screws on F_0 potentiometer shaft gear.

8. Loosen potentiometer retaining nut.

9. Withdraw potentiometer remembering orientation of potentiometer terminals.

10. Insert new potentiometer positioning shaft full clockwise (CW) as viewed from the shaft end.

11. Tighten potentiometer retaining nut.

12. Engage F_0 potentiometer shaft gear and tighten two set screws.

13. Loosen set screw on F_0 dial cord drum and note position of indicator. Rotate F_0 knob full counterclockwise (CCW). The stop of the potentiometer should be felt.

14. Position the F_0 indicator to position as noted in Step 13.

15. Tighten F_0 dial cord drum set screw.

16. Replace F_1 knob shaft into position and replace thrust washer and retaining ring.

17. With the F_1 potentiometer shaft fully clockwise (CW), slide the F_1 knob shaft gear up and intermesh with F_1 potentiometer shaft gear. Tighten gear set screws.

18. Rotate F_1 knob shaft fully counterclockwise (CCW) and tighten F_1 dial cord drum after positioning indicator as it was before Step 4 above.

19. Resolder leads

4.8 BACKWARD WAVE OSCILLATOR TUBE ADJUSTMENT

1. Replace the backward wave oscillator tube per Section 4.6 of the instruction manual. Do not connect to the power supply.

2. Turn the POWER switch to ON and adjust the ANODE and GRID voltages to the value specified on the data sheet for the new tube. It may be necessary to replace resistor R829 in order to obtain correct ANODE voltage. The correct value of R829 can be determined per Chart A. Check HEATER voltage for approximately 6.6 volts at (+) TP7 and (-) TP8.

CAUTION: These voltages are referenced to the cathode which is at a high voltage with respect to ground. Use a floating voltmeter.

Chart A

BWO Anode Voltage	R829*
206 - 264	402 K Ω
182 - 237	249 K Ω
158 - 207	165 K Ω
138 - 180	121 K Ω
122 - 160	93.1 K Ω
107 - 140	73.2 K Ω
95 - 125	60.4 K Ω
70 - 90	38.8 K Ω
64 - 85	34.8 K Ω
56 - 75	29.4 K Ω
59 - 66	25.5 K Ω

* 1/2 %, 1/2 watt, metal film

3. Turn the POWER switch to OFF and connect the backward wave oscillator tube to the power supply (P920 to J920). Monitor the HEATER VOLTAGE.

4. Turn the POWER switch to ON. Adjust the HEATER to 6.3 volts using R824 (see Figure 4-4).

5. Connect a power meter as shown in Figure 4-8.

6. Check the unleveled power output across the entire frequency band.

CAUTION: Do not exceed the thermistor power rating.

7. If the power is below specifications at any point, increase the ANODE voltage using the ANODE ADJUST, R806. (See Section 4.1.5 Paragraph 4.)

8. For leveled units, check the leveled power output and power variation across the entire frequency band.

9. If the unit does not meet the leveled output specification, make adjustments per Section 4.3.3 and Section 4.1.5.

10. Set FREQUENCY mode selector to SWEEP; $F_1 \rightarrow F_2$,

    set SWEEP; TIME to 0.1 seconds,

    set F_1 FREQUENCY control to 0 on logging scale,

    set F_2 FREQUENCY control to 100 on logging scale,

    and METER control to RF UNLEVELED.

11. Connect an oscilloscope to the unit as shown in Figure 4-8.

12. Set RETRACE control to OFF. The rf should be off during the entire retrace period. If it is not, increase the GRID voltage using R818

(GRID BIAS MAX ADJUST) so that this condition is met.

13. Set the MODULATION control to SQUARE WAVE. The rf should be off during the off portion of the square wave over the entire frequency band. If not, increase the GRID voltage slightly using R818.

14. Connect the power meter as shown in Figure 4-8. Measure the power output and power variation across the entire band during LEVELED operation. Use slow sweep or manual control.

15. Disconnect the power meter and connect an oscilloscope as shown in Figure 4-8.

16. Set FREQUENCY mode selector to SWEEP; $F_0 \pm \Delta F$, set SWEEP; time to 0.1 seconds and adjust the POWER SET control for calibrated power output.

17. Set F_0 FREQUENCY indicator to 0 on logging scale, and set the frequency meter to the frequency corresponding to this setting.

18. Adjust the START FREQUENCY ADJUSTMENT (R125) so that the frequency meter marker pip is in the center of the oscilloscope face.

    NOTE: ΔF AMPLITUDE control should be full on (clockwise).

19. Reduce the ΔF AMPLITUDE control while adjusting R125 so the pip remains in the center.

20. Move F_0 FREQUENCY indicator to 100 on the logging scale and set the frequency meter to the frequency corresponding to this setting.

21. Adjust the END FREQUENCY ADJUSTMENT (R121) so that the frequency meter marker pip is in the center of the oscilloscope face.

    NOTE: ΔF AMPLITUDE control should be full on (clockwise).

22. Reduce the ΔF AMPLITUDE control while adjusting R121 so the pip remains in the center.

23. Repeat Steps 16 through 22. Repeating the steps is necessary because of the interaction of R125 and R121.

4.9 WARRANTY

All workmanship and materials except the backward wave oscillator tube are guaranteed for one year. Details covering warranty adjustments are presented on "Shipment Damage Claim" page at the end of this manual.

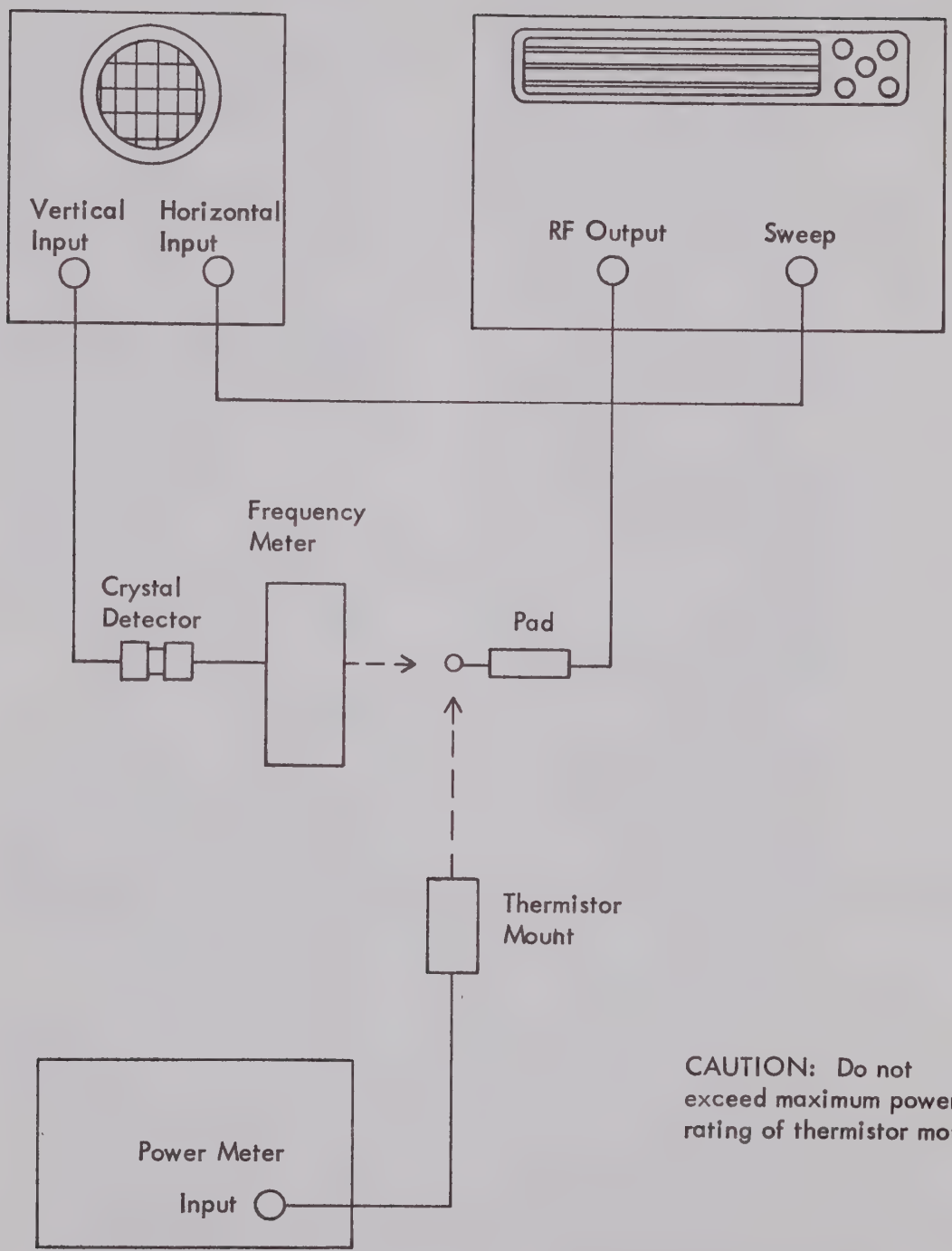

Vertical Input
Horizontal Input
RF Output
Sweep
Frequency Meter
Crystal Detector
Pad
Thermistor Mount
Power Meter
Input
CAUTION: Do not exceed maximum power rating of thermistor mount.

Figure 4-8

SECTION 5

CHARTS and GRAPHS

CHART #1
Information for Individual 630 Models

MODEL NUMBER	T902	R933	S913 HELIX/DELAY LINE (FULL SCALE)	J900 HELIX-SHAPER BOARD	V905 BWO	AT1 ATTENUATOR	CA1 COUPLER	BT1 BOLOMETER MOUNT	RT1 BARRETTER	RT2 BARRETTER	CURRENT TRIP-OUT VALUE	E_1	E_2	E_3	RF CIRCUIT DIAGRAM
631AB	7&8	12.5Ω	5 ma	950373	SE214C		950421 (17 db)	Model F101	174-2	174-2	5 ma				5-1
631AB-S1	7&8	12.5Ω	5 ma	950848	SE219-3		950425 (17 db)	Model F101	174-2	174-2	5 ma				5-1
631DB	7&8	12.5Ω	5 ma	950373	SE214C	SA-3			174-2	174-2	5 ma				5-3
631D8-S1	7&8	12.5Ω	5 ma	950848	SE219-3	950521			174-2	174-2	5 ma				5-3
632AB	7&9	12.5Ω	5 ma	950718	SE215A-2		950420 (17 db)	Model F101	174-2	174-2	3.5 ma				5-1
632DB	7&9	12.5Ω	5 ma	950718	SE215A-2	SA-4			174-2	174-2	3.5 ma	3 db Attenuator 252-4			5-3
633AB	7&9	12.5Ω	5 ma	950323	SE211A-8		250-3 (10 db)	Model F101	174-2	174-2	3.5 ma	LP Filter (FL1) RLC F-30 (8 Gc) 256-3		RF cable assembly 950356B-1	5-1
633AB-S1	7&9	12.5Ω	5 ma	950524	SE221-1		Selected 250-3 (10 db)	Model F101	174-2	174-2	3.5 ma	UG57B/U		RF cable assembly 950356B-1	5-1
633DB	7&9	12.5Ω	5 ma	950323	SE211A-1	SA-5			174-2	174-2	3.5 ma	LP Filter (FL1) RLC F-30 (8 Gc) 256-1			5-3
633DB-S1	7&9	12.5Ω	5 ma	950524	SE221-1	950522			174-2	174-2	3.5 ma	Filter (FL1) Microlab #LA70N (7 Gc) 256-4			5-3
634AB	7&9	12.5Ω	5 ma	950371	SE209-1		950886-1 (10 db)	Model F101	174-2	174-2	3.5 ma	Coax cable 950871C-3			5-1
635AB	7&9	12.5Ω	5 ma	950430	SE209A-2		250-27 (10 db)	Model F101	174-2	174-2	3.5 ma		Coax to WG Adapter 253-1	Bend 950627B	5-1
635AE	7&8	1.05Ω	50 ma	950433	VA173A		250-28 (17 db)	Model F101	174-2	174-2	30 ma	Coax cable 950871C-3 & coax to WG Adapter 253-1	Bend 950627B		5-2
637AB	7&9	12.5Ω	5 ma	950329	SE216-2		250-17 (10 db)	Model 950614	174-3	174-3	3.5 ma			Bend 950628B	5-5
637AE	7&8	1.05Ω	50 ma	950330	VA162A		250-21 (17 db)	Model 950614	174-3	174-3	30 ma	Flexible Waveguide 254-7	Bend 950628B		5-6

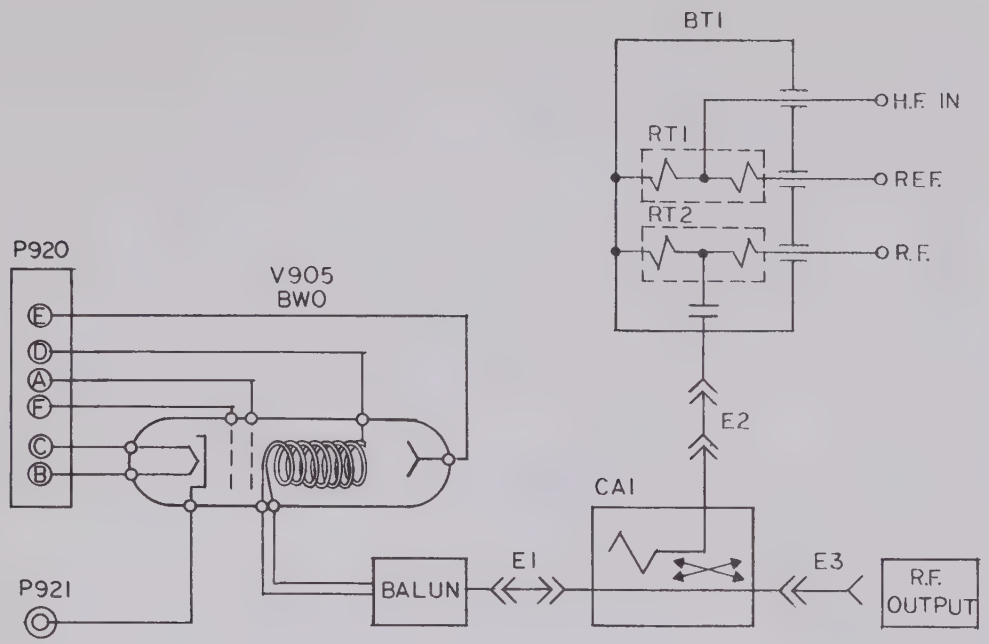

BT1
H.F. IN
RT1
REF.
RT2
R.F.
P920
V905
BWO
E
D
A
F
C
B
E2
CA1
P921
BALUN
E1
E3
R.F.
OUTPUT

FIG. 5-1

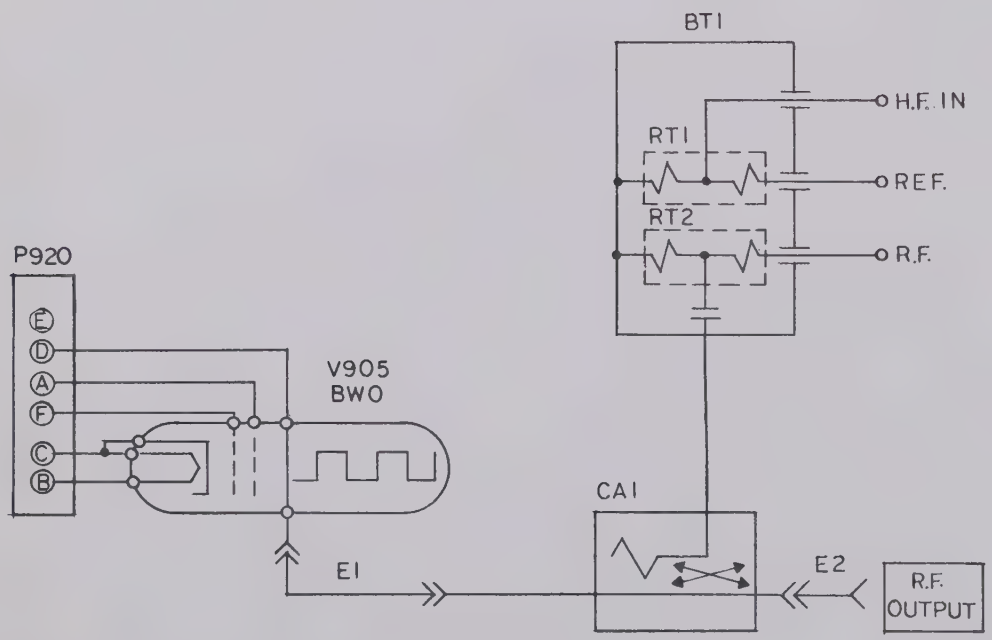

BT1
H.F. IN
RT1
REF.
RT2
R.F.
P920
V905
BWO
E
D
A
F
C
B
CA1
E1
E2
R.F.
OUTPUT

FIG. 5-2

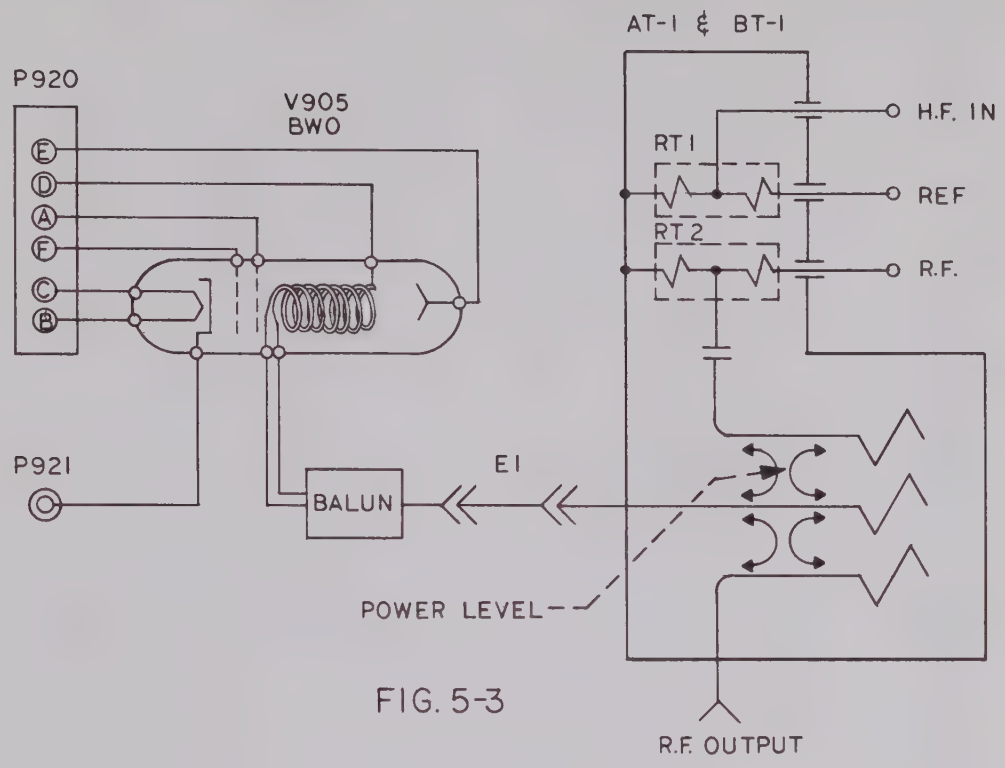

AT-1 & BT-1
P920
V905
BWO
H.F. IN
RT1
REF
RT2
R.F.
P921
BALUN
E1
POWER LEVEL
R.F. OUTPUT

FIG. 5-3

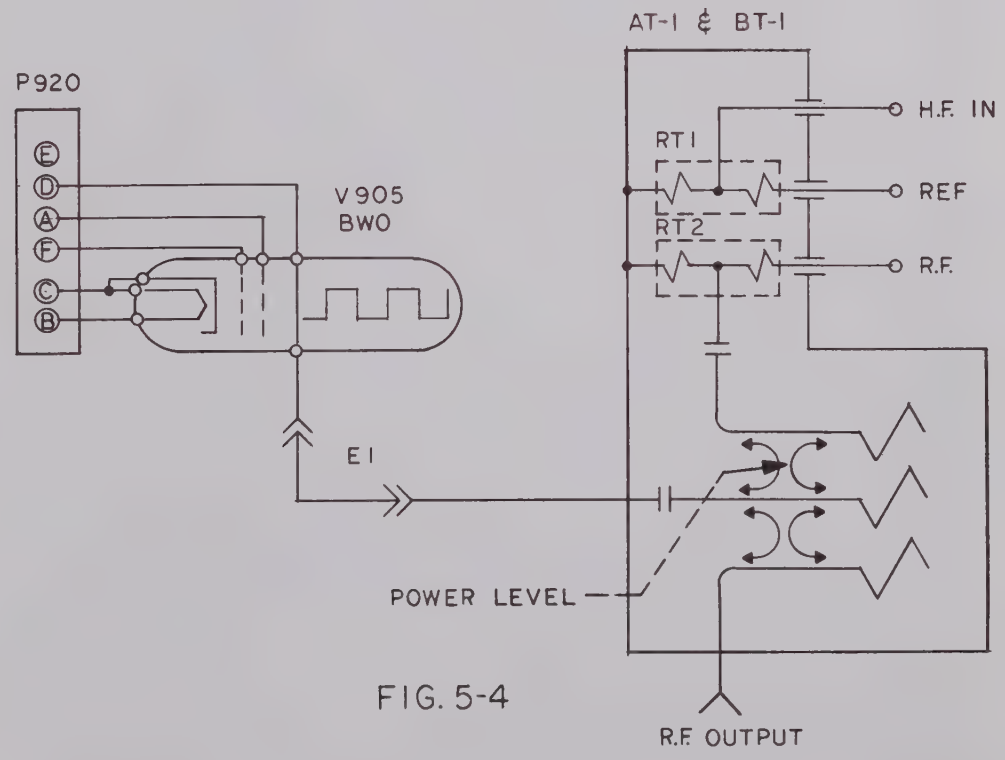

AT-1 & BT-1
P920
H.F. IN
RT1
V905
BWO
REF
RT2
R.F.
E1
POWER LEVEL
R.F. OUTPUT

FIG. 5-4

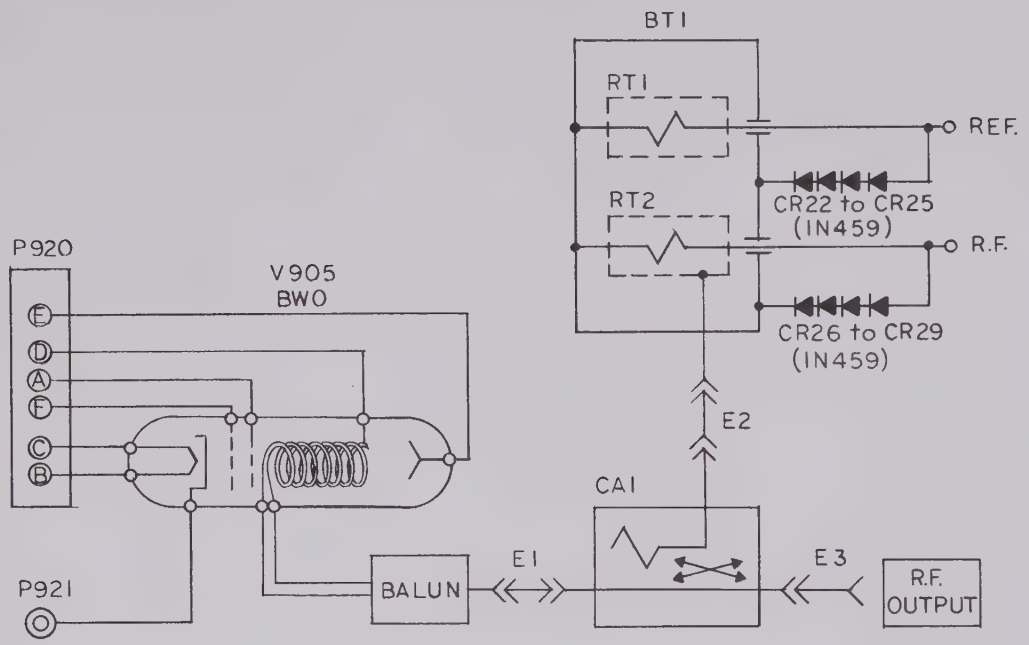

BT1
RT1
REF.
CR22 to CR25
(IN459)
RT2
R.F.
CR26 to CR29
(IN459)
P920
V905
BWO
E
D
A
F
C
B
E2
CA1
P921
BALUN
E1
E3
R.F.
OUTPUT

FIG. 5-5

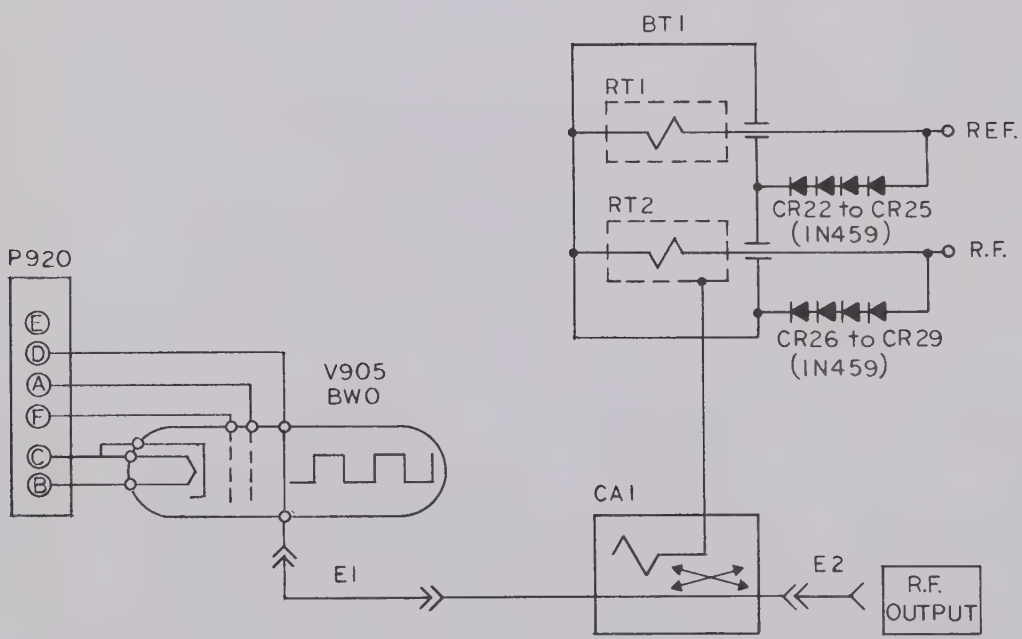

BT1
RT1
REF.
CR22 to CR25
(IN459)
RT2
R.F.
CR26 to CR29
(IN459)
P920
E
D
A
F
C
B
V905
BWO
CA1
E1
E2
R.F.
OUTPUT

FIG. 5-6

SECTION 6

PARTS LIST

The following parts list is arranged in two groups according to Page number: Pages 6-1 thru 6-6 contain those parts which are common to all 630 Series instruments, and Pages 6-7 thru 6-10 contain those parts which vary from model to model.

For the units listed on pages 6-7 thru 6-10 (parts which vary from model to model) the following letter designations are used;

630A ( ) Sweeper which is bolometer leveled and includes sampler only.

630D ( ) Sweeper which includes sampler attenuator.

The second suffix letter designates the tube manufacturer as follows:

(B) Stewart, PM Focused

(E) Varian

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
C101 and C102	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C103	12-13	Capacitor, fixed, ceramic, .002 mf, 500 v
C104	12-2	Capacitor, fixed, ceramic, .001 mf, 500 v
C105	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C106	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C107 thru C110	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C111	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C112	12-27	Capacitor, fixed, ceramic, 270 pf, 500 v
C114	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C115	12-22	Capacitor, fixed, ceramic, 100 pf, 500 v
A2C1 and A2C2	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
A2C3	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
A2C4 and A2C5	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
A2C6	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
A2C7	13-40	Capacitor, fixed, elec., 100 mf, 10 v
A2C8	13-33	Capacitor, fixed, elec., 10 mf, 100 v
A2C9	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
A2C10	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C301	12-2	Capacitor, fixed, ceramic, .001 mf, 500 v
C302	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C303	12-2	Capacitor, fixed, ceramic, .001 mf, 500 v
C305 thru C307	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C308	12-24	Capacitor, fixed, ceramic, 390 pf, 500 v
C309	12-2	Capacitor, fixed, ceramic, .001 mf, 500 v
C310	12-31	Capacitor, fixed, ceramic, .0 2 mf, 500 v
C312*	11-2	Capacitor, fixed, mica, 24 pf, 500 v
C313	12-18	Capacitor, fixed, ceramic, 200 pf, 500 v
C401	12-9	Capacitor, fixed, ceramic, .05 mf, 75 v
C402	12-21	Capacitor, fixed, ceramic, 27 pf, 500 v
C403	12-9	Capacitor, fixed, ceramic, .05 mf, 75 v
C404	12-21	Capacitor, fixed, ceramic, 27 pf, 500 v
C405	12-9	Capacitor, fixed, ceramic, .05 mf, 75 v
C406	12-21	Capacitor, fixed, ceramic, 27 pf, 500 v
C501	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C502	12-22	Capacitor, fixed, ceramic, 100 pf, 500 v
C503 and C504	14-26	Capacitor, fixed, paper, .01 mf, 200 v, 2%
C505	12-27	Capacitor, fixed, ceramic, 270 pf, 500 v
C506	12-18	Capacitor, fixed, ceramic, 200 pf, 500 v
C507	12-27	Capacitor, fixed, ceramic, 270 pf, 500 v
C508		Not used
C509	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C510	12-22	Capacitor, fixed, ceramic, 100 pf, 500 v
C511	12-13	Capacitor, fixed, ceramic, .005 mf, 500 v
C512	12-27	Capacitor, fixed, ceramic, 270 pf, 500 v
C513	12-26	Capacitor, fixed, ceramic, 500 pf, 500 v
C601 and C602	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C603 and C604	12-26	Capacitor, fixed, ceramic, 500 pf, 500 v
C605		Not used
C607*	12-9	Capacitor, fixed, ceramic, .05 mf, 75 v
C608	12-22	Capacitor, fixed, ceramic, 100 pf, 500 v
C609	13-44	Capacitor, fixed, ceramic, 5 mf, 50 v
C610	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C611	13-40	Capacitor, fixed, elec., 100 mf, 10 v dc
C612	12-9	Capacitor, fixed, ceramic, .05 mf, 75 v
C613	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
C701	14-23	Capacitor, fixed, paper, 10 mf, 200 v
C702	14-24	Capacitor, fixed, paper, 1 mf, 200 v
C703	14-25	Capacitor, fixed, paper, .1 mf, 200 v
C704	14-26	Capacitor, fixed, paper, .01 mf, 200 v
C751	16-8	Capacitor, fixed, feed thru, 1000 pf, 500 v
C752	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C753	12-12	Capacitor, fixed, ceramic, 30 pf, 6 kv
C754	12-21	Capacitor, fixed, ceramic, 27 pf, 600 v
C755		Not used
C756	12-22	Capacitor, fixed, ceramic, 100 pf, 600 v
C757*	12-47	Capacitor, fixed, ceramic, 120 pf, 600 v
C758	12-1	Capacitor, fixed, ceramic, 15 pf, 500 v
C759	12-12	Capacitor, fixed, ceramic, 30 pf, 6 kv
C760 and C761	12-21	Capacitor, fixed, ceramic, 27 pf, 600 v
C762	16-8	Capacitor, fixed, feed thru, 1000 pf, 500 v
C763	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C764 and C765	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C766	16-9	Capacitor, fixed, feed thru, 100 pf, 500 v
C767 and C768	12-21	Capacitor, fixed, ceramic, 27 pf, 600 v
C801	13-48	Capacitor, fixed, elec., 1 mf, 450 v
C802	13-20	Capacitor, fixed, elec., 50 mf, 25 v dc
C803 and C804	13-43	Capacitor, fixed, elec., 10 mf, 150 v dc
C805	12-22	Capacitor, fixed, elec., 100 pf, 500 v
C806 and C808	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C807	12-3	Capacitor, fixed, ceramic, .01 mf, 500 v
C901	13-46	Capacitor, fixed, elec., .50 mf/150 v; 100 mf/50 v
C902	13-38	Capacitor, fixed, elec., 100 mf, 250 v
C903	13-54	Capacitor, fixed, elec., 80/50 mf, 150 v
C904	12-22	Capacitor, fixed, ceramic, 100 pf, 500 v
C905	12-17	Capacitor, fixed, ceramic, .005 mf, 1 kv
C906	12-28	Capacitor, fixed, ceramic, .001 mf, 6 kv
C907 and C908	16-7	Capacitor, fixed, paper, 2 mf, 2 kv
C909	12-28	Capacitor, fixed, ceramic, .001 mf, 6 kv
C910	13-36	Capacitor, fixed, elec., 100/100 mf, 50 v
C911	13-38	Capacitor, fixed, elec., 100 mf, 250 v
C912	12-30	Capacitor, fixed, ceramic, 1.5 pf, 6 kv
C913	13-42	Capacitor, fixed, elec., 10 mf, 450 v dc
C914	12-28	Capacitor, fixed, elec., .001 mf, 6 kv
C915	13-35	Capacitor, fixed, elec., 500 mf, 25 v dc
C916	12-17	Capacitor, fixed, ceramic, .005 mf, 1 kv
C917 and C918	13-42	Capacitor, fixed, elec., 10 mf, 450 v dc
C920	13-9	Capacitor, fixed, elec., 3000 mf, 15 v
C921	12-28	Capacitor, fixed, elec., .001 mf, 6 kv
C923	12-34	Capacitor, fixed, ceramic, .1 mf, 100 v
C924 and C925	12-33	Capacitor, fixed, ceramic, .01 mf, 3000 v
C926	12-2	Capacitor, fixed, ceramic, .001 mf, 500 v
CR101 thru CR103	81-41	Diode, 1N459
CR104	81-88	Diode, 1N3041A, zener

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A2CR1	81-75	Diode, 1N823
A2CR2 and A2CR3	81-41	Diode, 1N459
CR301 thru CR308	81-41	Diode, 1N459
CR401 thru CR412	81-41	Diode, 1N459
CR501	81-60	Diode, HD1811
CR502 thru CR504	81-41	Diode, 1N459
CR601 thru CR604	81-41	Diode, 1N459
CR605	81-60	Diode, 1N1811
CR701	81-41	Diode, 1N459
CR751	81-60	Diode, HD1811
CR801	81-41	Diode, 1N459
CR802	81-97	Diode, 1N965B, zener
CR803	81-20	Diode, DI-46/1N4385
CR804	81-77	Diode, PSI-18199 or 1N752A, zener, 5.6 v ± 10%
CR805 thru CR807	81-41	Diode, 1N459
CR901 thru CR907	81-20	Diode, DI-46/1N4385
CR908	81-69	Diode, DI-1154
CR909 thru CR912	81-20	Diode, DI-46/1N4385
CR914 and CR915	81-93	Diode, MR322R
CR916 and CR917	81-41	Diode, 1N459
CR919	81-71	Diode, 1N752A, zener
CR920	81-41	Diode, 1N459
Q101	81-85	Transistor, 2N2484 or 2N2483
Q102 thru Q106	81-73	Transistor, 2N706
Q107 and Q108	81-72	Transistor, 2N699
Q109 and Q110	81-115	Transistor, 2N3565
A2Q1	81-71	Transistor, 2N697
A2Q2 and A2Q3	81-114	Transistor, 2N3638A
A2Q4	81-113	Transistor, SP9965
A2Q5 thru A2Q7	81-114	Transistor, 2N3638A
A2Q8	81-113	Transistor, SP9965
A2Q9 and A2Q10	81-114	Transistor, 2N3638A
A2Q11	81-71	Transistor, 2N697
A2Q12	81-114	Transistor, 2N3638A
A2Q13	81-72	Transistor, 2N699
Q301 and Q302	81-115	Transistor, 2N3565
Q303	81-71	Transistor, 2N697
Q304	81-115	Transistor, 2N3565
Q305	81-116	Transistor, 2N3646/2N706
Q306	81-114	Transistor, 2N3638A
Q307	81-72	Transistor, 2N699 (RCA)
Q308 and Q309	81-116	Transistor, S18563/2N3646
Q310 and Q311	81-114	Transistor, 2N3638A
Q312 and Q313	81-116	Transistor, S18563/2N3646
Q314	81-73	Transistor, 2N3646/2N706
Q401 and Q402	81-90	Transistor, S6793 (Fairchild)
Q403	81-114	Transistor, 2N3638A
Q404	81-51	Transistor, 2N404
Q405 and Q406	81-114	Transistor, 2N3638A
Q407 and Q408	81-90	Transistor, S6793 (Fairchild)
Q409	81-114	Transistor, 2N3638A
Q410	81-51	Transistor, 2N404
Q411 and Q412	81-114	Transistor, 2N3638A
Q413 and Q414	81-90	Transistor, S6793 (Fairchild)
Q415	81-114	Transistor, 2N3638A
Q416	81-51	Transistor, 2N404
Q417 thru Q419	81-114	Transistor, 2N3638A
Q501 thru Q503	81-51	Transistor, 2N404
Q504 and Q505	81-73	Transistor, 2N706
Q506	81-90	Transistor, S6793
Q507	81-73	Transistor, 2N706
Q508	81-51	Transistor, 2N404
Q509	81-73	Transistor, 2N706
Q510	81-51	Transistor, 2N404
Q601 and Q602	81-73	Transistor, 2N706
Q603 and Q604	81-51	Transistor, 2N404
Q605	81-73	Transistor, 2N706
Q606	81-73	Transistor, 2N706
Q607	81-51	Transistor, 2N404
Q608 and Q609	81-73	Transistor, 2N706
Q610	81-51	Transistor, 2N404
Q611 thru Q614	81-73	Transistor, 2N706
Q615	81-51	Transistor, 2N404
Q701	81-71	Transistor, 2N697
Q702 thru Q704	81-51	Transistor, 2N404
Q705	81-72	Transistor, 2N699
Q751	81-71	Transistor, 2N697
Q752	81-73	Transistor, 2N706
Q801 and Q802	81-90	Transistor, S6793
Q803	81-72	Transistor, 2N699
Q804 thru Q807	81-51	Transistor, 2N404
Q808	81-72	Transistor, 2N699

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Q809	81-71	Transistor, 2N697
Q810 and Q811	81-51	Transistor, 2N404
Q901	81-89	Transistor, 2N1537 (Motorola)
Q902	81-74	Transistor, 2N1540
Q903 and Q904	81-86	Transistor, 2N2147
Q905	81-112	Transistor, 40251 (RCA)
Q906	81-77	Transistor, 2N697
R101 and R102	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R103		Not used
R104	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%
R105 and R106	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R107	41-330 Ω	Resistor, fixed, comp., 330 Ω, 1/2 w, 10%
R108		Not used
R109	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R110	43-3.9 K	Resistor, fixed, comp., 3.9 K, 2 w, 10%
R111	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R112	41-3.9 K	Resistor, fixed, comp., 3.9 K, 1/2 w, 10%
R113	41-1.2 K	Resistor, fixed, comp., 1/2 K, 1/2 w, 10%
R114	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R115	42-4.7 K	Resistor, fixed, comp., 4.7 K, 1 w, 10%
R116 thru R118	57-15 K	Resistor, fixed, metal film, 15 K, 1/2 w, 1/2%
R119	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R120	56-15 K	Resistor, fixed, metal film, 15 K, 1/2 w, 1%
R121	71-94	Resistor, variable, Borg, 5 K
R122	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R123	41-150 K	Resistor, fixed, comp., 150 K, 1/2 w, 10%
R124	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R125	71-90	Resistor, 200 Ω, variable, Borg
R126	56-1 K	Resistor, fixed, metal film, 1 K, 1/2 w, 1%
R127	41-150 K	Resistor, fixed, comp., 150 K, 1/2 w, 10%
R128	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
A2R1	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
A2R2	43-10 K	Resistor, fixed, comp., 10 K, 2 w, 10%
A2R3	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
A2R4	56-19.6 K	Resistor, fixed, metal film, 19.6 K, 1/2 w, 1%
A2R5	44-1 Ω	Resistor, fixed, BW, 1 Ω, 1/2 w, 5%
A2R6 and A2R7	56-19.6 K	Resistor, fixed, metal film, 19.6 K, 1/2 w, 1%
A2R8	41-22 Ω	Resistor, fixed, comp., 22 Ω, 1/2 w, 10%
A2R9	71-90	Resistor, variable, 200 Ω, 20 turn, WW
A2R10 and A2R11	56-1.21 K	Resistor, fixed, metal film, 1.21 K, 1/2 w, 1%
A2R12	44-1 Ω	Resistor, fixed, BW, 1 Ω, 1/2 w, 5%
A2R13	41-1.5 K	Resistor, fixed, comp., 1.5 K, 1/2 w, 10%
A2R14	41-8.2 K	Resistor, fixed, comp., 8.2 K, 1/2 w, 10%
A2R15	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
A2R16	41-820 Ω	Resistor, fixed, comp., 820 Ω, 1/2 w, 10%
A2R17	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
A2R18	71-90	Resistor, variable, 20 turn, WW, 200 Ω
A2R19	56-1.21 K	Resistor, fixed, metal film, 1.21 K, 1/2 w, 1%
A2R20 thru A2R22	56-19.6 K	Resistor, fixed, metal film, 19.6 K, 1/2 w, 1%
A2R23	41-330 Ω	Resistor, fixed, comp., 330 Ω, 1/2 w, 10%
A2R24	56-1.21 K	Resistor, fixed, metal film, 1.21 K, 1/2 w, 1%
A2R25	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
A2R26	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
A2R27	56-4.99 K	Resistor, fixed, metal film, 4.99 K, 1/2 w, 1%
A2R28	56-34 K	Resistor, fixed, metal film, 34 K, 1/2 w, 1%
A2R29 and A2R30	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%
A2R31	56-15 K	Resistor, fixed, metal film, 15 K, 1/2 w, 1%
A2R32	56-49.9 K	Resistor, fixed, metal film, 49.9 K, 1/2 w, 1%
A2R33	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
A2R34*	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
A2R35	41-5.6 K	Resistor, fixed, comp., 5.6 K, 1/2 w, 10%
A2R36	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%
A2R37	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
A2R38	41-1.2 K	Resistor, fixed, comp., 1.2 K, 1/2 w, 10%
A2R39	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
A2R40	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
A2R41 and A2R42	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R301	41-220 K	Resistor, fixed, comp., 220 K, 1/2 w, 10%
R302	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R303	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R304	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R305	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R306	41-220 K	Resistor, fixed, comp., 220 K, 1/2 w, 10%
R307	56-4.99 K	Resistor, fixed, metal film, 4.99 K, 1/2 w, 1%
R308	56-12.1 K	Resistor, fixed, metal film, 12.1 K, 1/2 w, 1%
R309	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R310	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R311	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R312	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R313	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R314	41-1.8 M	Resistor, fixed, comp., 1.8 M, 1/2 w, 10%
R315	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R316	41-39 K	Resistor, fixed, comp., 8.2 K, 1/2 w, 10%
R317	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R318	41-470 K	Resistor, fixed, comp., 470 K, 1/2 w, 10%
R319	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R320	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R321	41-56 K	Resistor, fixed, comp., 56 K, 1/2 w, 10%
R322	41-120 K	Resistor, fixed, comp., 120 K, 1/2 w, 10%
R323	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R324	41-470 K	Resistor, fixed, comp., 470 K, 1/2 w, 10%
R325	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R326	41-5.6 K	Resistor, fixed, comp., 5.6 K, 1/2 w, 10%
R327	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R328	41-15 M	Resistor, fixed, comp., 15 M, 1/2 w, 10%
R329 and R330	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R331	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R332	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R333	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R334	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R335	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R336	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R337	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R338	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R339 and R340	41-220 K	Resistor, fixed, comp., 220 K, 1/2 w, 10%
R341	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R342	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R343	41-22 Ω	Resistor, fixed, comp., 22 Ω, 1/2 w, 10%
R344	41-330 Ω	Resistor, fixed, comp., 330 Ω, 1/2 w, 10%
R345	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
R401	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R402	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R403 thru		
R405	57-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 1/2%
R406	41-5.6	Resistor, fixed, comp., 5.6 K, 1/2 w, 10%
R407	71-94	Resistor, variable, 5 K, 15 turn, Borg
R408	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R409	41-2.7 K	Resistor, fixed, comp., 2.7 K, 1/2 w, 10%
R410	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R411	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R412	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R413	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R414	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R415	41-47 Ω	Resistor, fixed, comp., 47 Ω, 1/2 w, 10%
R416	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R417	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R418	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R419	41-180 K	Resistor, fixed, comp., 180 K, 1/2 w, 10 %
R420	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 10%
R421	56-4.99 K	Resistor, fixed, metal film, 4.99 K, 1/2 w, 1%
R422	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R423	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R424	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R425		Not used
R426	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R427	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R428 thru		
R430	57-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1/2%
R431	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R432	71-94	Resistor, variable, 5 K, 15 turn, Borg
R433	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R434	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R435	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R436	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R437	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R438	41-47 Ω	Resistor, fixed, comp., 47 Ω, 1/2 w, 10%
R439	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R440	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R441	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R442	41-180 K	Resistor, fixed, comp., 180 K, 1/2 w, 10%
R443	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R444	56-4.99 K	Resistor, fixed, metal film, 4.99 K, 1/2 w, 1%
R445	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R446	41-15 K	Resistor, fixed, metal film, 15 K, 1/2 w, 10%
R447	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R448	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R449	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R450	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R451 thru		
R453	57-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1/2%
R454	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R455	71-94	Resistor, variable, 5 K, 15 turn, Borg
R456	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R457	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R458	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R459	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R460	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R461	41-47 Ω	Resistor, fixed, comp., 47 Ω, 1/2 w, 10%
R462	41-1 M	Resistor, fixed, comp., 1 M, 1/2 w, 10%
R463	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R464	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R465	41-180 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R466	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
R467	56-4.99 K	Resistor, fixed, metal film, 4.99 K, 1/2 w, 1%
R468	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R469	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R470	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R471		Not used
R472	56-10 K	Resistor, fixed, metal film, 10 K, 1/2 w, 1%
R473	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R474	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R475	41-150 K	Resistor, fixed, comp., 150 K, 1/2 w, 10%
R476	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R501	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
R502	41-680 Ω	Resistor, fixed, comp., 680 Ω, 1/2 w, 10%
R503	41-150 Ω	Resistor, fixed, comp., 150 Ω, 1/2 w, 10%
R504	71-95	Resistor, variable, 2 K, Borg
R505	41-330 Ω	Resistor, fixed, comp., 330 Ω, 1/2 w, 10%
R506	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R507	41-330 Ω	Resistor, fixed, comp., 330 Ω, 1/2 w, 10%
R508	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R509	41-1.2 K	Resistor, fixed, comp., 1.2 K, 1/2 w, 10%
R510 and		
R511	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R512 and		
R513	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R514	56-100 K	Resistor, fixed, metal film, 110 K, 1/2 w, 1%
R515	56-113 K	Resistor, fixed, metal film, 113 K, 1/2 w, 1%
R516	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R517	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R518	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R519	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R520	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R521	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R522	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
R523	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R524	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R525	41-680 Ω	Resistor, fixed, comp., 680 Ω, 1/2 w, 10%
R526	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R527	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R528	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R529	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R530	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R531	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R532	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R533	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R534	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R535	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R536		Not used
R537	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R601	56-2.61 K	Resistor, fixed, metal film, 2.61 K, 1/2 w, 1%
R602	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R603 and		
R604	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R605	56-3.16 K	Resistor, fixed, metal film, 3.16 K, 1/2 w, 1%
R606 and		
R607	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R608	41-220 Ω	Resistor, fixed, comp., 220 Ω, 1/2 w, 10%
R609	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R610 and		
R611	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R612 and		
R613	41-5.6 K	Resistor, fixed, comp., 5.6 K, 1/2 w, 10%
R614	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R615	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
R616	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R617*	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R618	41-18 Ω	Resistor, fixed, comp., 18 Ω, 1/2 w, 10%
R619	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R620	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R621	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R622	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R623	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%
R624	41-1.8 K	Resistor, fixed, comp., 1.8 K, 1/2 w, 10%
R625	71-95	Resistor, variable, 2 K, Borg
R626	41-56 Ω	Resistor, fixed, comp., 56 Ω, 1/2 w, 10%
R627	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R628	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R629	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R630	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
R631	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R632	41-3.3 K	Resistor, fixed, comp., 3.3 K, 1/2 w, 10%
R633	41-82 K	Resistor, fixed, comp., 82 K, 1/2 w, 10%
R634	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R635	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R636	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R637 and R638	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R639	44-1 Ω	Resistor, fixed, BW, 1 Ω, 1/2 w, 5%
R640	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R701	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R702	41-6.8 K	Resistor, fixed, comp., 6.8 K, 1/2 w, 10%
R703	71-90	Resistor, variable, 200 Ω, Borg
R704	41-56 K	Resistor, fixed, comp., 56 K, 1/2 w, 10%
R705	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R706	56-1.78 K	Resistor, fixed, metal film, 1.78 K, 1/2 w, 1%
R707	56-868 Ω	Resistor, fixed, metal film, 866 Ω, 1/2 w, 1%
R708	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R709	71-90	Resistor, variable, 200 Ω, Borg
R710	56-1.62 K	Resistor, fixed, metal film, 1.62 K, 1/2 w, 1%
R711	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R712 and R713		Not used
R714	56-49.9 Ω	Resistor, fixed, metal film, 49.9 Ω, 1/2w, 10%
R715	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R716	56-1 K	Resistor, fixed, metal film, 1 K, 1/2 w, 1%
R717	43-3.9 K	Resistor, fixed, comp., 3.9 K, 2 w, 10%
R718	43-9.2 K	Resistor, fixed, comp., 8.2 K, 2 w, 10%
R719	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R751	41-4.7 K	Resistor, fixed, comp., 4.7 K, 1/2 w, 10%
R752	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R753	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R754 and R755	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R756	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R801	56-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1%
R802	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R803	56-23.7 K	Resistor, fixed, metal film, 23.7 K, 1/2w, 10%
R804	56-1.69 K	Resistor, fixed, metal film, 1.69 K, 1/2 w, 10%
R805	41-190 K	Resistor, fixed, comp., 190 K, 1/2 w, 10%
R806	71-94	Resistor, variable, 5 K, (CTS)
R807	41-5.6 K	Resistor, fixed, comp., 5.6 K, 1/2 w, 10%
R808	41-2.2 K	Resistor, fixed, comp., 2.2 K, 1/2 w, 10%
R809	56-17.8 K	Resistor, fixed, metal film, 17.8 K, 1/2 w, 1%
R810	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R811	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R812	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
R813	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R814 and R815	41-3.9 K	Resistor, fixed, comp., 3.9 K, 1/2 w, 10%
R816	56-29.4 K	Resistor, fixed, metal film, 29.4 K, 1/2 w, 1%
R817	56-7.5 K	Resistor, fixed, metal film, 7.5 K, 1/2 w, 1%
R818	71-75	Resistor, variable, (CTS type 115 WW), 10 K, 2 w
R819	41-470 K	Resistor, fixed, comp., 470 K, 1/2 w, 10%
R820	41-330 K	Resistor, fixed, comp., 330 K, 1/2 w, 10%
R821	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R822 and R823	41-39 Ω	Resistor, fixed, comp., 39 Ω, 1/2 w, 10%
R824	71-96	Resistor, variable, 100 Ω, (Borg)
R825	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%
R826	41-150 Ω	Resistor, fixed, comp., 150 Ω, 1/2 w, 10%
R827	41-220 Ω	Resistor, fixed, comp., 220 Ω, 1/2 w, 10%
R828	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
R829		See Addendum Sheet "A"
R830	41-820 Ω	Resistor, fixed, comp., 820 Ω, 1/2 w, 10%
R901 and R902	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R903	43-68 Ω	Resistor, fixed, comp., 68 Ω, 2 w, 10%
R904 and R905	41-100 K	Resistor, fixed, comp., 100 K, 1/2 w, 10%
R906 and R907	41-10 Ω	Resistor, fixed, comp., 10 Ω, 1/2 w, 10%
R908	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R909	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R910	41-56 Ω	Resistor, fixed, comp., 56 Ω, 1/2 w, 10%
R911	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R912	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R913	41-56 Ω	Resistor, fixed, comp., 56 Ω, 1/2 w, 10%
R914	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%
R915	41-100 Ω	Resistor, fixed, comp., 100 Ω, 1/2 w, 10%
R916	41-56 Ω	Resistor, fixed, comp., 56 Ω, 1/2 w, 10%
R917 thru R922	55-40	Resistor, fixed, metal film, 464 K, 1 w, 1%
R923	43-68 K	Resistor, fixed, comp., 68 K, 2 w, 10%
R924	62-1	Resistor, fixed, WW, 10 K, 10 w, 5%
R925	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R926 and R927	74-6	Resistor, variable, 10 turn, 1 K, Beckman
R928	71-82	Resistor, variable, 10 turn, 10 K, Beckman
R929	74-6	Resistor, variable, 10 turn, 1 K, Beckman
R30	71-72	Resistor, variable, 100 Ω, 2 w, 10%
R931 and R932	74-6	Resistor, variable, 1 K, 10 turn, 1%, Beckman
R933		Not used
R934	55-3	Resistor, fixed, WW, 2.63 Ω, 1/2 w, 1%
R935	71-73	Resistor, variable, (John Fluke), 1000 Ω, 2 w
R936		Not used
R937	71-77	Resistor, variable, 10 K, 1/2 w, 20%
R938	71-79	Resistor, variable, 1 K, 20%
R939 thru R943	52-200 K	Resistor, fixed, metal film, 200 K, 2 w, 5%
R944	61-22	Resistor, fixed, comp., 8 M, 4 w, 20%, 5 kv
R945	56-374 K	Resistor, fixed, metal film, 374 K, 1/2 w, 1%
R946	71-71	Resistor, variable, V taper, 5 M, 1/2 w, 10%
R947	61-13	Resistor, fixed, WW, 2.5 K, 5 w, 10%
R948	41-27 Ω	Resistor, fixed, comp., 27 Ω, 1/2 w, 10%
R949	61-15	Resistor, fixed, WW, 3.6 Ω, 5 w, 10%
R950	63-11	Resistor, fixed, WW, 15 K, 20 w, 5%
R951	41-150 K	Resistor, fixed, comp., 150 K, 1/2 w, 10%

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	
R952	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%	
R953 and R954	42-15 K	Resistor, fixed, comp., 15 K, 1 w, 10%	
R955	45-4.7 Ω	Resistor, fixed, comp., 4.7 Ω, 1 w, 5%	
R960	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%	
R961	42-1 M	Resistor, fixed, comp., 1 M, 1 w, 10%	
R962	56-69.8 K	Resistor, fixed, metal film, 69.8 K, 1/2w, 1%	
R963	56-18.7 K	Resistor, fixed, metal film, 18.7 K, 1/2 w, 1%	
R964	62-1	Resistor, fixed, comp., 10 K, 10 w, 10%	
R969	42-100 Ω	Resistor, fixed, comp., 100 Ω, 1 w, 10%	
R970	41-470 Ω	Resistor, fixed, comp., 470 Ω, 1/2 w, 10%	
R971	41-1 K	Resistor, fixed, comp., 1 K, 1/2 w, 10%	
L501	92-7	Inductor, 10 mh, coil (Miller 70F105A1)	
L601 and L602	92-6	Inductor, 2.2 mh, choke	
L751 thru L761	92-5	Inductor, 3.3 mh, coil, RF (Miller 70F335A1)	
T501 and T751	91-187	Transformer Assembly 950273 (Stanford Applied Engr. SAET-330)	
T901	91-195	Transformer, Tranex Number 4-0896	
T902	91-185	Transformer, Tranex Number 40588	
K701	106-24	Relay, SPDT, 10 K coil (P and B RS5D)	
K901	106-25	Relay, Time Delay (Amperite 6N060)	
K902 and K903	106-30	Relay, 100 v dc, (P and B KA146??)	
K904	106-29	Relay, RS5D, 6 v dc	
M901	86-53	Meter, 0 - 1 ma, 50 Ω, full scale, 2%	
M902	87-3	Elapsed Time indicator	
S901	101-18	Switch, Pushbutton (Switchcraft 201)	
S902	102-124	Switch, Rotary, 630902	
S903	102-121	Switch, Rotary, 630903	
S904	102-125	Switch, Rotary, 630904	
S905	102-122	Switch, Rotary, 630905	
S906	102-123	Switch, Rotary, 630906	
S907		Not used	
S908	101-5	Switch, Toggle, DPST	
S909 and S910	101-17	Switch, Snap Action (Cherry E33-20A)	
S911	102-128	Switch, Lever, 630-911	
S912	101-8	Switch, Pushbutton (Normally closed)	
S913	102-136	Switch, Slide	
DS903	126-1	Bulb, (NE-2)	
V901 thru V903	111-8068	Tube, electron, 8068	
V904	111-6CW5	Tube, electron, 6CW5	
F901	121-3	Fuse, 3 AG, 2 ampere, 250 v	
F902	121-8	Fuse, 3 AG, 8 ampere, 250 v	
F903	121-3	Fuse, 3 AG, 3 ampere, 250 v	

Model 631AB, 631AB-S1

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
	Model 631AB	
R10	56-127 K	Resistor, fixed, metal film, 127 K, 1/2 w, 1%
R11	56-178 K	Resistor, fixed, metal film, 178 K, 1/2 w, 1%
R12	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R13	56-412 K	Resistor, fixed, metal film, 412 K, 1/2 w, 1%
R14	56-487 K	Resistor, fixed, metal film, 487 K, 1/2 w, 1%
R15	56-536 K	Resistor, fixed, metal film, 536 K, 1/2 w, 1%
R16	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R17	56-392 K	Resistor, fixed, metal film, 392 K, 1/2 w, 1%
R18	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R19	56-511 K	Resistor, fixed, metal film, 511 K, 1/2 w, 1%
R20	56-383 K	Resistor, fixed, metal film, 383 K, 1/2 w, 1%
R21	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R22	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diodes, 1N459
	ML950373	Helix Shaping PC Board Assembly
	SE214C	Tube, Stewart
	Model 631AB	
R10	56-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1%
R11	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R12	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R13	56-698 K	Resistor, fixed, metal film, 698 K, 1/2 w, 1%
R14	56-649 K	Resistor, fixed, metal film, 649 K, 1/2 w, 1%
R15	56-453 K	Resistor, fixed, metal film, 453 K, 1/2 w, 1%
R16	56-604 K	Resistor, fixed, metal film, 604 K, 1/2 w, 1%
R17	56-476 K	Resistor, fixed, metal film, 576 K, 1/2 w, 1%
R18	56-365 K	Resistor, fixed, metal film, 365 K, 1/2 w, 1%
R19	56-576 K	Resistor, fixed, metal film, 576 K, 1/2 w, 1%
R20	56-464 K	Resistor, fixed, metal film, 464 K, 1/2 w, 1%
R21	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R22	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950384	Helix Shaping PC Board Assembly
	SE219	Tube, Stewart

Model 632AB, 633AB

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
	Model 632AB	
R10	56-124 K	Resistor, fixed, metal film, 124 K, 1/2 w, 1%
R11	56-165 K	Resistor, fixed, metal film, 165 K, 1/2 w, 1%
R12	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R13	56-274 K	Resistor, fixed, metal film, 274 K, 1/2 w, 1%
R14	56-412 K	Resistor, fixed, metal film, 412 K, 1/2 w, 1%
R15	56-301 K	Resistor, fixed, metal film, 301 K, 1/2 w, 1%
R16	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R17	56-348 K	Resistor, fixed, metal film, 348 K, 1/2 w, 1%
R18	56-205 K	Resistor, fixed, metal film, 205 K, 1/2 w, 1%
R19	56-210 K	Resistor, fixed, metal film, 210 K, 1/2 w, 1%
R20	56-261 K	Resistor, fixed, metal film, 261 K, 1/2 w, 1%
R21	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R22	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950319	Helix Shaping PC Board Assembly
	SE215A-2	Tube, Stewart
	Model 633AB	
R10	56-127 K	Resistor,
R11	56-137 K	Resistor, fixed, metal film, 137 K, 1/2 w, 1%
R12	56-309 K	Resistor, fixed, metal film, 309 K, 1/2 w, 1%
R13	56-383 K	Resistor, fixed, metal film, 383 K, 1/2 w, 1%
R14	56-309 K	Resistor, fixed, metal film, 309 K, 1/2 w, 1%
R15	56-232 K	Resistor, fixed, metal film, 232 K, 1/2 w, 1%
R16	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R17	56-215 K	Resistor, fixed, metal film, 215 K, 1/2 w, 1%
R18	56-191 K	Resistor, fixed, metal film, 191 K, 1/2 w, 1%
R19	56-154 K	Resistor, fixed, metal film, 154 K, 1/2 w, 1%
R20	56-118 K	Resistor, fixed, metal film, 118 K, 1/2 w, 1%
R21	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R22	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950323	Helix Shaping PC Board Assembly
	SE211A-8	Tube, Stewart

Model 633AB-S1, 634AB

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 633AB-S1		
R10	56-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1%
R11	56-124 K	Resistor, fixed, metal film, 124 K, 1/2 w, 1%
R12	56-287 K	Resistor, fixed, metal film, 287 K, 1/2 w, 1%
R13	56-357 K	Resistor, fixed, metal film, 357 K, 1/2 w, 1%
R14	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R15	56-243 K	Resistor, fixed, metal film, 243 K, 1/2 w, 1%
R16	56-261 K	Resistor, fixed, metal film, 261 K, 1/2 w, 1%
R17	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R18	56-205 K	Resistor, fixed, metal film, 250 K, 1/2 w, 1%
R19	56-169 K	Resistor, fixed, metal film, 169 K, 1/2 w, 1%
R20	56-200 K	Resistor, fixed, metal film, 200 K, 1/2 w, 1%
R21	41-12 K	Resistor, fixed, comp., 12 K, 1/2 w, 10%
R22	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950524	Helix Shaping PC Board Assembly
	SE221-1	Tube, Stewart
Model 634AB		
R10	56-118 K	Resistor, fixed, metal film, 118 K, 1/2 w, 1%
R11	56-412 K	Resistor, fixed, metal film, 412 K, 1/2 w, 1%
R12	56-681 K	Resistor, fixed, metal film, 681 K, 1/2 w, 1%
R13	56-523 K	Resistor, fixed, metal film, 523 K, 1/2 w, 1%
R14	56-604 K	Resistor, fixed, metal film, 604 K, 1/2 w, 1%
R15	56-536 K	Resistor, fixed, metal film, 536 K, 1/2 w, 1%
R16 and R17	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R18 and R19	56-332 K	Resistor, fixed, metal film, 332 K, 1/2 w, 1%
R20	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R21	41-12 K	Resistor, fixed, comp., 12 K, 1/2 w, 10%
R22	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950371	Helix Shaping PC Board Assembly
	SE209-1	Tube, Stewart

Model 635AB, 635AE

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 635AB		
R10	56-80.6 K	Resistor, fixed, metal film, 80.6 K, 1/2 w, 1%
R11	56-221 K	Resistor, fixed, metal film, 211 K, 1/2 w, 1%
R12	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R13		Not used
R14	56-309 K	Resistor, fixed, metal film, 309 K, 1/2 w, 1%
R15	56-287 K	Resistor, fixed, metal film, 287 K, 1/2 w, 1%
R16	56-274 K	Resistor, fixed, metal film, 274 K, 1/2 w, 1%
R17	56-200 K	Resistor, fixed, metal film, 200 K, 1/2 w, 1%
R18	56-205 K	Resistor, fixed, metal film, 205 K, 1/2 w, 1%
R19	56-165 K	Resistor, fixed, metal film, 165 K, 1/2 w, 1%
R20	56-137 K	Resistor, fixed, metal film, 137 K, 1/2 w, 1%
R21	41-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R22	41-33 K	Resistor, fixed, comp., 33 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950430	Helix Shaping PC Board Assembly
	SE209-1	Tube, Stewart
Model 635AE		
R10	56-110 K	Resistor, fixed, metal film, 110 K, 1/2 w, 1%
R11	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R12	56-549 K	Resistor, fixed, metal film, 549 K, 1/2 w, 1%
R13 and R14	56-523 K	Resistor, fixed, metal film, 523 K, 1/2 w, 1%
R15	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R16		Not used
R17	56-261 K	Resistor, fixed, metal film, 261 K, 1/2 w, 1%
R18	56-210 K	Resistor, fixed, metal film, 210 K, 1/2 w, 1%
R19	56-357 K	Resistor, fixed, metal film, 357 K, 1/2 w, 1%
R20	56-287 K	Resistor, fixed, metal film, 287 K, 1/2 w, 1%
R21	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 1%
R22	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950328	Helix Shaping PC Board Assembly
	VA173A	Tube, Varian

Model 637AB, 637AE

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 637AB		
R10	56-68.1 K	Resistor, fixed, metal film, 68.1 K, 1/2 w, 1%
R11	56-383 K	Resistor, fixed, metal film, 383 K, 1/2 w, 1%
R12	56-590 K	Resistor, fixed, metal film, 590 K, 1/2 w, 1%
R13	56-348 K	Resistor, fixed, metal film, 348 K, 1/2 w, 1%
R14	56-442 K	Resistor, fixed, metal film, 442 K, 1/2 w, 1%
R15	56-294 K	Resistor, fixed, metal film, 294 K, 1/2 w, 1%
R16	56-374 K	Resistor, fixed, metal film, 374 K, 1/2 w, 1%
R17	56-243 K	Resistor, fixed, metal film, 243 K, 1/2 w, 1%
R18	56-196 K	Resistor, fixed, metal film, 196 K, 1/2 w, 1%
R19	56-316 K	Resistor, fixed, metal film, 316 K, 1/2 w, 1%
R20	56-178 K	Resistor, fixed, metal film, 178 K, 1/2 w, 1%
R21	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R22	41-27 K	Resistor, fixed, comp., 27 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR29	81-41	Diode, 1N459
	ML950329	Helix Shaping PC Board Assembly
	SE216-2	Tube, Stewart
Model 637AE		
R10	56-147 K	Resistor, fixed, metal film, 147 K, 1/2 w, 1%
R11		Not used
R12	56-1.40 M	Resistor, fixed, metal film, 1.40 M, 1/2 w, 1%
R13	56-768 K	Resistor, fixed, metal film, 768 K, 1/2 w, 1%
R14	56-1.40 M	Resistor, fixed, metal film, 1.40 M, 1/2 w, 1%
R15	56-604 K	Resistor, fixed, metal film, 604 K, 1/2 w, 1%
R16	56-866 K	Resistor, fixed, metal film, 866 K, 1/2 w, 1%
R17	56-536 K	Resistor, fixed, metal film, 536 K, 1/2 w, 1%
R18	56-590 K	Resistor, fixed, metal film, 590 K, 1/2 w, 1%
R19	56-715 K	Resistor, fixed, metal film, 715 K, 1/2 w, 1%
R20	56-127 K	Resistor, fixed, metal film, 127 K, 1/2 w, 1%
R21	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R22	41-56 K	Resistor, fixed, comp., 56 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R31	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR29	81-41	Diode, 1N459
	ML950330	Helix Shaping PC Board Assembly
	VA162A	Tube, Varian

Model 631DB, 631DB-S1

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 631DB		
R10	56-127 K	Resistor, fixed, metal film, 127 K, 1/2 w, 1%
R11	56-178 K	Resistor, fixed, metal film, 178 K, 1/2 w, 1%
R12	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R13	56-412 K	Resistor, fixed, metal film, 412 K, 1/2 w, 1%
R14	56-487 K	Resistor, fixed, metal film, 487 K, 1/2 w, 1%
R15	56-536 K	Resistor, fixed, metal film, 536 K, 1/2 w, 1%
R16	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R17	56-392 K	Resistor, fixed, metal film, 392 K, 1/2 w, 1%
R18	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R19	56-511 K	Resistor, fixed, metal film, 511 K, 1/2 w, 1%
R20	56-383 K	Resistor, fixed, metal film, 383 K, 1/2 w, 1%
R21	41-18 K	Resistor, fixed, comp., 18 K, 1/2 w, 10%
R22	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950373	Helix Shaping PC Board
	SE214C	Tube, Stewart
Model 631DB-S1		
R10	56-110 K	Resistor, fixed, metal film, 110 K, 1/2 w, 1%
R11	56-402 K	Resistor, fixed, metal film, 402 K, 1/2 w, 1%
R12	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R13	56-698 K	Resistor, fixed, metal film, 698 K, 1/2 w, 1%
R14	56-649 K	Resistor, fixed, metal film, 649 K, 1/2 w, 1%
R15	56-453 K	Resistor, fixed, metal film, 453 K, 1/2 w, 1%
R16	56-604 K	Resistor, fixed, metal film, 604 K, 1/2 w, 1%
R17	56-576 K	Resistor, fixed, metal film, 576 K, 1/2 w, 1%
R18	56-365 K	Resistor, fixed, metal film, 365 K, 1/2 w, 1%
R19	56-576 K	Resistor, fixed, metal film, 576 K, 1/2 w, 1%
R20	56-464 K	Resistor, fixed, metal film, 464 K, 1/2 w, 1%
R21	41-22 K	Resistor, fixed, comp., 22 K, 1/2 w, 10%
R22	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950384	Helix Shaping PC Board Assembly
	SE219	Tube, Stewart

Model 632DB, 633DB

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 632DB		
R10	56-124 K	Resistor, fixed, metal film, 124 K, 1/2 w, 1%
R11	56-165 K	Resistor, fixed, metal film, 165 K, 1/2 w, 1%
R12	56-422 K	Resistor, fixed, metal film, 422 K, 1/2 w, 1%
R13	56-274 K	Resistor, fixed, metal film, 274 K, 1/2 w, 1%
R14	56-412 K	Resistor, fixed, metal film, 412 K, 1/2 w, 1%
R15	56-301 K	Resistor, fixed, metal film, 301 K, 1/2 w, 1%
R16	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R17	56-348 K	Resistor, fixed, metal film, 348 K, 1/2 w, 1%
R18	56-205 K	Resistor, fixed, metal film, 205 K, 1/2 w, 1%
R19	56-210 K	Resistor, fixed, metal film, 210 K, 1/2 w, 1%
R20	56-261 K	Resistor, fixed, metal film, 261 K, 1/2 w, 1%
R21	56-15 K	Resistor, fixed, comp., 15 K, 1/2 w, 10%
R22	41-47 K	Resistor, fixed, comp., 47 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950319	Helix Shaping PC Board Assembly
	SA-4	Sampler Attenuator Assembly
	SE215A-2	Tube, Stewart
Model 633DB		
R10	56-127 K	Resistor, fixed, metal film, 127 K, 1/2 w, 1%
R11	56-137 K	Resistor, fixed, metal film, 137 K, 1/2 w, 1%
R12	56-309 K	Resistor, fixed, metal film, 309 K, 1/2 w, 1%
R13	56-383 K	Resistor, fixed, metal film, 383 K, 1/2 w, 1%
R14	56-309 K	Resistor, fixed, metal film, 309 K, 1/2 w, 1%
R15	56-232 K	Resistor, fixed, metal film, 232 K, 1/2 w, 1%
R16	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R17	56-215 K	Resistor, fixed, metal film, 215 K, 1/2 w, 1%
R18	56-191 K	Resistor, fixed, metal film, 191 K, 1/2 w, 1%
R19	56-154 K	Resistor, fixed, metal film, 154 K, 1/2 w, 1%
R20	56-118 K	Resistor, fixed, metal film, 118 K, 1/2 w, 1%
R21	41-10 K	Resistor, fixed, comp., 10 K, 1/2 w, 10%
R22	41-68 K	Resistor, fixed, comp., 68 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR20	81-41	Diode, 1N459
	ML950323	Helix Shaping PC Board Assembly
	SA-5	Sampler Attenuator Assembly
	SE211A-1	Tube, Stewart

Model 633DB-S1

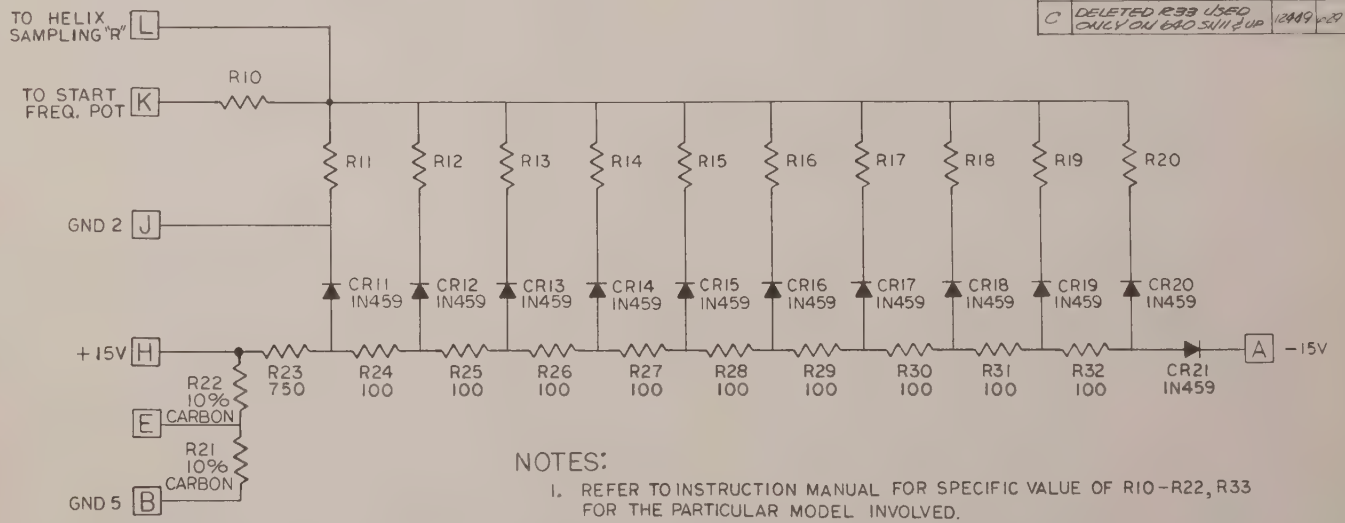
CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
Model 633DB-S1		
R10	56-100 K	Resistor, fixed, metal film, 100 K, 1/2 w, 1%
R11	56-124 K	Resistor, fixed, metal film, 124 K, 1/2 w, 1%
R12	56-287 K	Resistor, fixed, metal film, 287 K, 1/2 w, 1%
R13	56-357 K	Resistor, fixed, metal film, 357 K, 1/2 w, 1%
R14	56-324 K	Resistor, fixed, metal film, 324 K, 1/2 w, 1%
R15	56-243 K	Resistor, fixed, metal film, 243 K, 1/2 w, 1%
R16	56-261 K	Resistor, fixed, metal film, 261 K, 1/2 w, 1%
R17	56-237 K	Resistor, fixed, metal film, 237 K, 1/2 w, 1%
R18	56-205 K	Resistor, fixed, metal film, 205 K, 1/2 w, 1%
R19	56-169 K	Resistor, fixed, metal film, 169 K, 1/2 w, 1%
R20	56-200 K	Resistor, fixed, metal film, 200 K, 1/2 w, 1%
R21	41-12 K	Resistor, fixed, comp., 12 K, 1/2 w, 10%
R22	41-39 K	Resistor, fixed, comp., 39 K, 1/2 w, 10%
R23	56-750 Ω	Resistor, fixed, metal film, 750 Ω, 1/2 w, 1%
R24 thru R32	56-100 Ω	Resistor, fixed, metal film, 100 Ω, 1/2 w, 1%
CR11 thru CR21	81-41	Diode, 1N459
	ML950524	Helix Shaping PC Board Assembly
	SE221-1	Tube, Stewart

SECTION 7

SCHEMATICS

Circuit	PC Board Number	Reference Designation Prefix	Schematic Number
Diode Shaper	10	10	900604B
Cathode Supply	100	100	900599C
Low Voltage Power Supplies	200	200	900766C
Sweep Circuit	300	300	900600C
Markers Circuit	400	400	900652C
Reference Oscillator & Modulator	500	500	900661C
Leveler Circuit	600	600	900602C
Helix Overcurrent	700	700	900598C
Transfer Oscillator	750	750	900597C
Elevated Supply	800	800	900673C
Chassis	-	900	900660 D

SYM	DESCRIPTION	NO	DATE	BY
A	APPD. FOR PRODUCTION	~	9-25-3	D.P
B	ADDED USAGE ON 640 ADDED R33 & * EFFECTIVE ON ALL SER. NO.	~	12-19-3	D.P
C	DELETED R33 USED ONLY ON 640 SN11 & UP	12949	12-20-4	V.L



NOTES:

1. REFER TO INSTRUCTION MANUAL FOR SPECIFIC VALUE OF R10-R22, R33 FOR THE PARTICULAR MODEL INVOLVED.
2. UNLESS OTHERWISE SPECIFIED:
   2A. ALL RESISTORS IN OHMS, 1/2W, 1%, METAL FILM.
3. SQUARE ( ) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC900.

SER. NO. 11-UP	640
SER. NO. 18-UP	630
NEXT ASSY	USED ON

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

MATERIAL

MATERIAL STOCK NO

FINISH OR TREATMENT

DRAWN	Dave Presley	9-25-63
ENG	R.L.H.	9/30/63
PROD		

SCALE

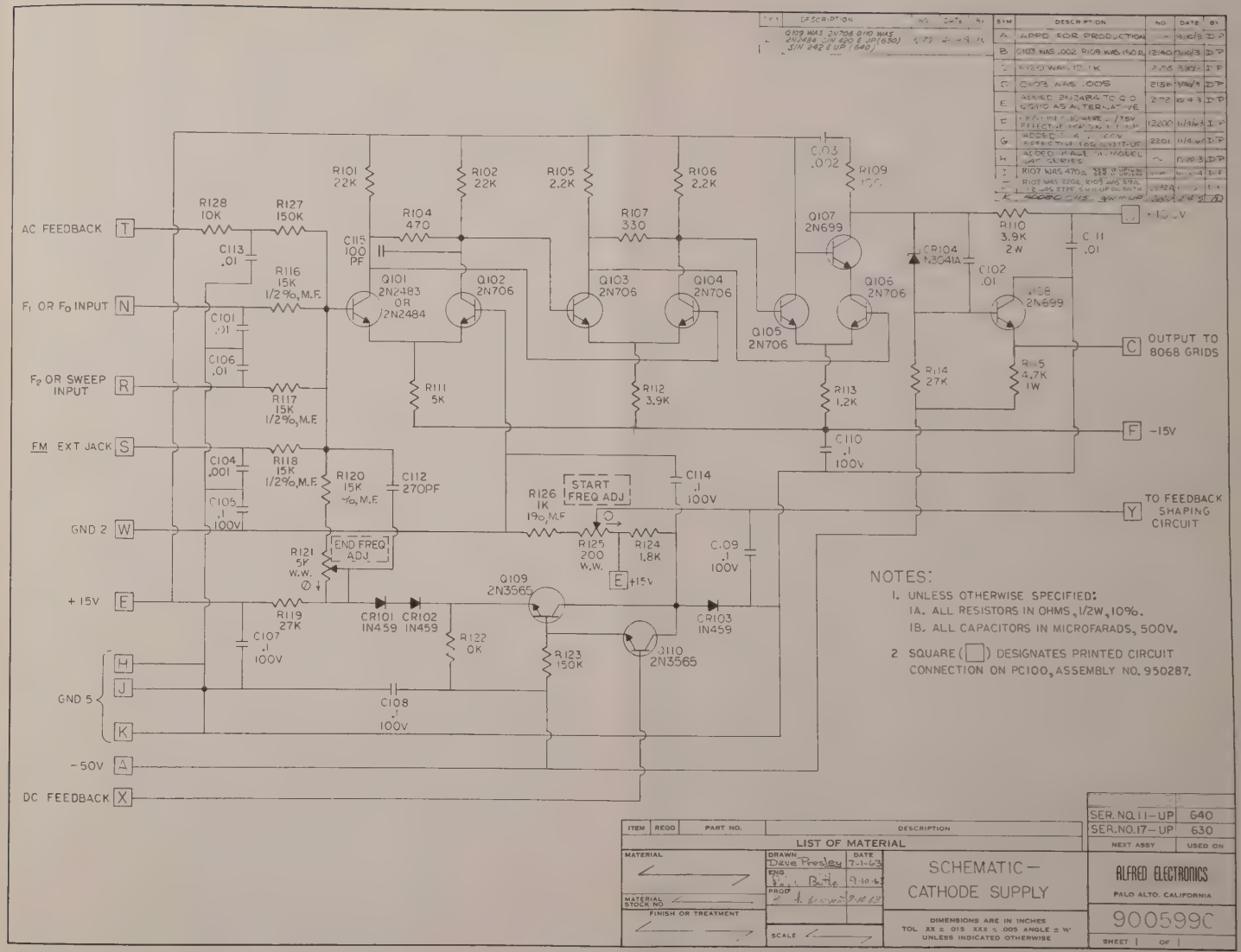
SCHEMATIC - DIODE SHAPER

DIMENSIONS ARE IN INCHES
TOL. .XX ± .015, .XXX ± .005, ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900604B

SHEET 1 OF 1



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARE ( ) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC100, ASSEMBLY NO. 950287.

SYM	DESCRIPTION	NO.	DATE	BY
A	ADDED FOR PRODUCTION	—	9/6/63	DP
B	C103 WAS .002 R108 WAS 150Ω	12140	9/10/63	DP
C	R120 WAS 10.1K	2155	9/30/63	DP
D	C103 WAS .005	2158	9/30/63	DP
E	ADDED 2N2484 TO Q101 Q110 AS ALTERNATIVE	2172	10/9/63	DP
F	[illegible] SELECTED FOR [illegible]	12200	11/19/63	DP
G	ADDED [illegible] SPECIFIED FOR [illegible]	2201	11/19/63	DP
H	ADDED [illegible] MODEL [illegible]	—	11/20/63	DP
I	R107 WAS 470Ω [illegible]	[illegible]	[illegible]	[illegible]
J	R107 WAS 220Ω, R109 AND R114 [illegible]	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	[illegible]	[illegible]

ITEM	REQD	PART NO.	DESCRIPTION
LIST OF MATERIAL			

MATERIAL	DRAWN Dave Presley	DATE 7-1-63
MATERIAL STOCK NO.	ENG [illegible]	DATE 9-10-63
FINISH OR TREATMENT	PROD [illegible]	DATE 9-10-63
SCALE		

SCHEMATIC — CATHODE SUPPLY

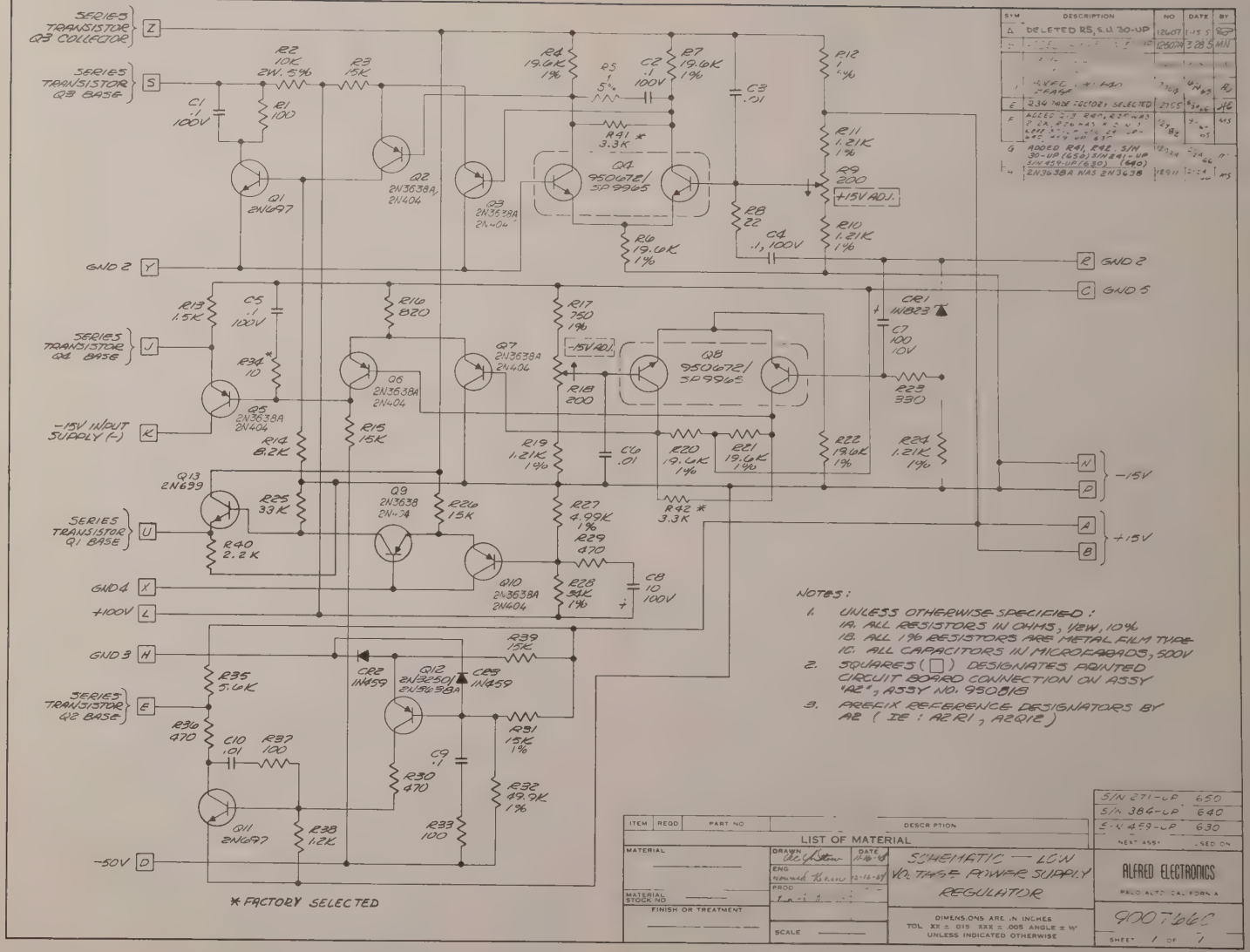
DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

SER. NO. 11 — UP	640
SER. NO. 17 — UP	630
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900599C

SHEET 1 OF 1



SYM	DESCRIPTION	NO	DATE	BY
A	DELETED R5, S.N. 30-UP	12607	1-15-68	
		12607A	2-28-68	MN
E	2.3Ω MADE (SCOTCH) SELECTED	2755	4-26-68	JG
F	ADDED 2.7 R4?, R25 WAS 2.1K, R26 WAS 2.4K, R39 WAS 2.7K, R40 WAS 2.2K, R41 WAS 3.3K, R42 WAS 3.3K S/N 459-UP (630)	2788	9-4-68	MS
G	ADDED R41, R42. S/N 30-UP (650) S/N 241-UP S/N 459-UP (690)	2824	9-26-68	MS
H	2N3638A WAS 2N3638	2891	12-2-68	MS

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, ½W, 10%
   1B. ALL 1% RESISTORS ARE METAL FILM TYPE
   1C. ALL CAPACITORS IN MICROFARADS, 500V
2. SQUARES (□) DESIGNATES PRINTED CIRCUIT BOARD CONNECTION ON ASSY "A2", ASSY NO. 950815
3. PREFIX REFERENCE DESIGNATORS BY A2 (IE : A2R1 , A2Q12)

ITEM	REQD	PART NO	DESCRIPTION

LIST OF MATERIAL

MATERIAL

MATERIAL STOCK NO

FINISH OR TREATMENT

DRAWN DATE 2-26-68

ENG

PROD

SCALE

SCHEMATIC — LOW VOLTAGE POWER SUPPLY REGULATOR

DIMENSIONS ARE IN INCHES
TOL XX ± .015 XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

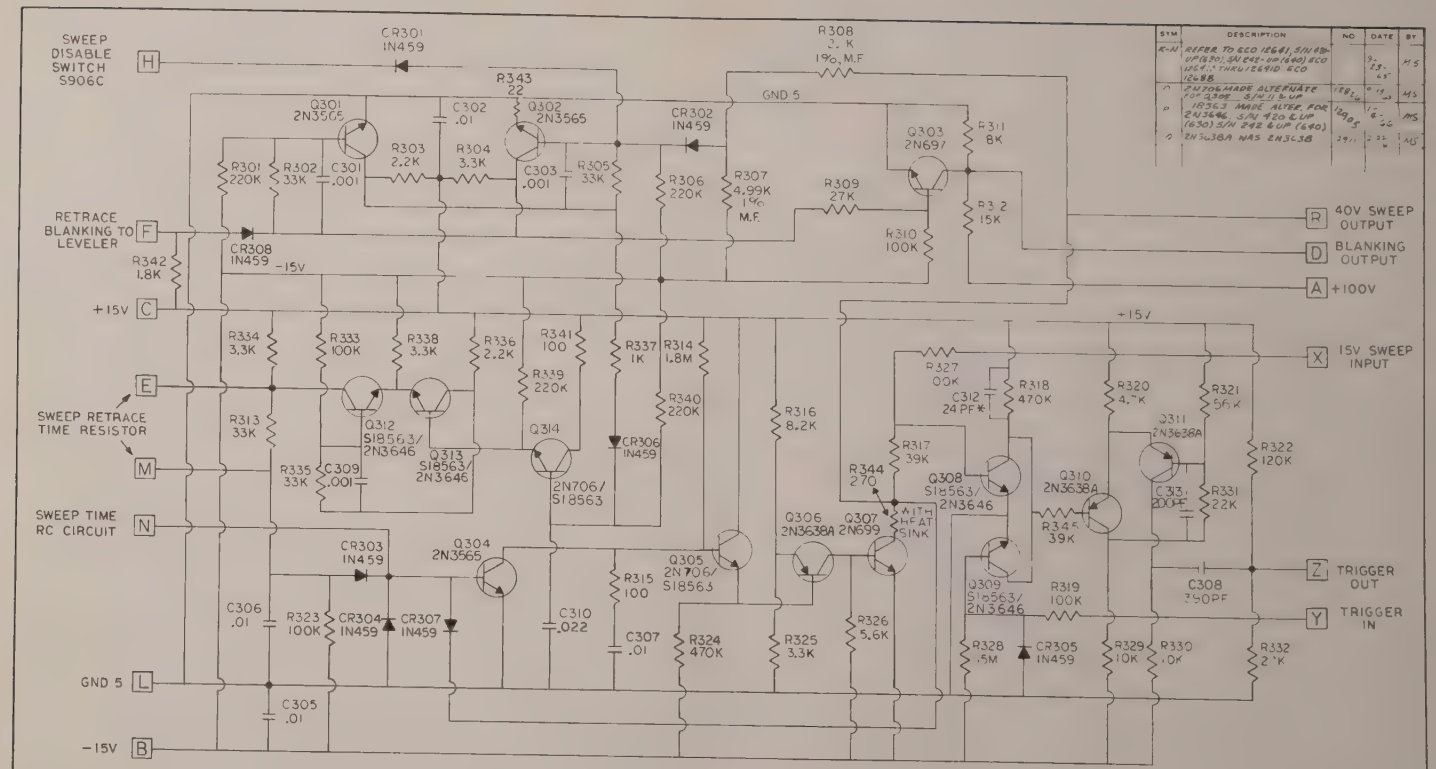
S/N 271-UP	650
S/N 384-UP	640
S/N 459-UP	630

NEXT ASSY USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900766

SHEET 1 OF 1



SYM	DESCRIPTION	NO	DATE	BY
A-M	REFER TO ECO 1664J, S/N 480 UP (630); S/N 648-UP (640) ECO 1664K THRU 1664D ECO 1698		3-25-63	MS
N	2N706 MADE ALTERNATE FOR Q308 S/N 11 & UP	178	9-19-63	MS
P	1833.3 MADE ALTER FOR 2N3646 S/N 420 & UP (630) S/N 842 & UP (640)	180	11-6-63	MS
Q	2N3638A WAS 2N3638	191	2-25-64	MS

NOTES:

1. UNLESS OTHERWISE SPECIFIED
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARE ( ) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC300, ASSEMBLY NO. 950276.

* FACTORY SELECTED

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

MATERIAL	DRAWN Dave Presley	DATE 7-9-63
	ENG Ralph Bull	9-10-63
MATERIAL STOCK NO	PROD Frank Vernon	
FINISH OR TREATMENT	SCALE	

SCHEMATIC– SWEEP CIRCUIT

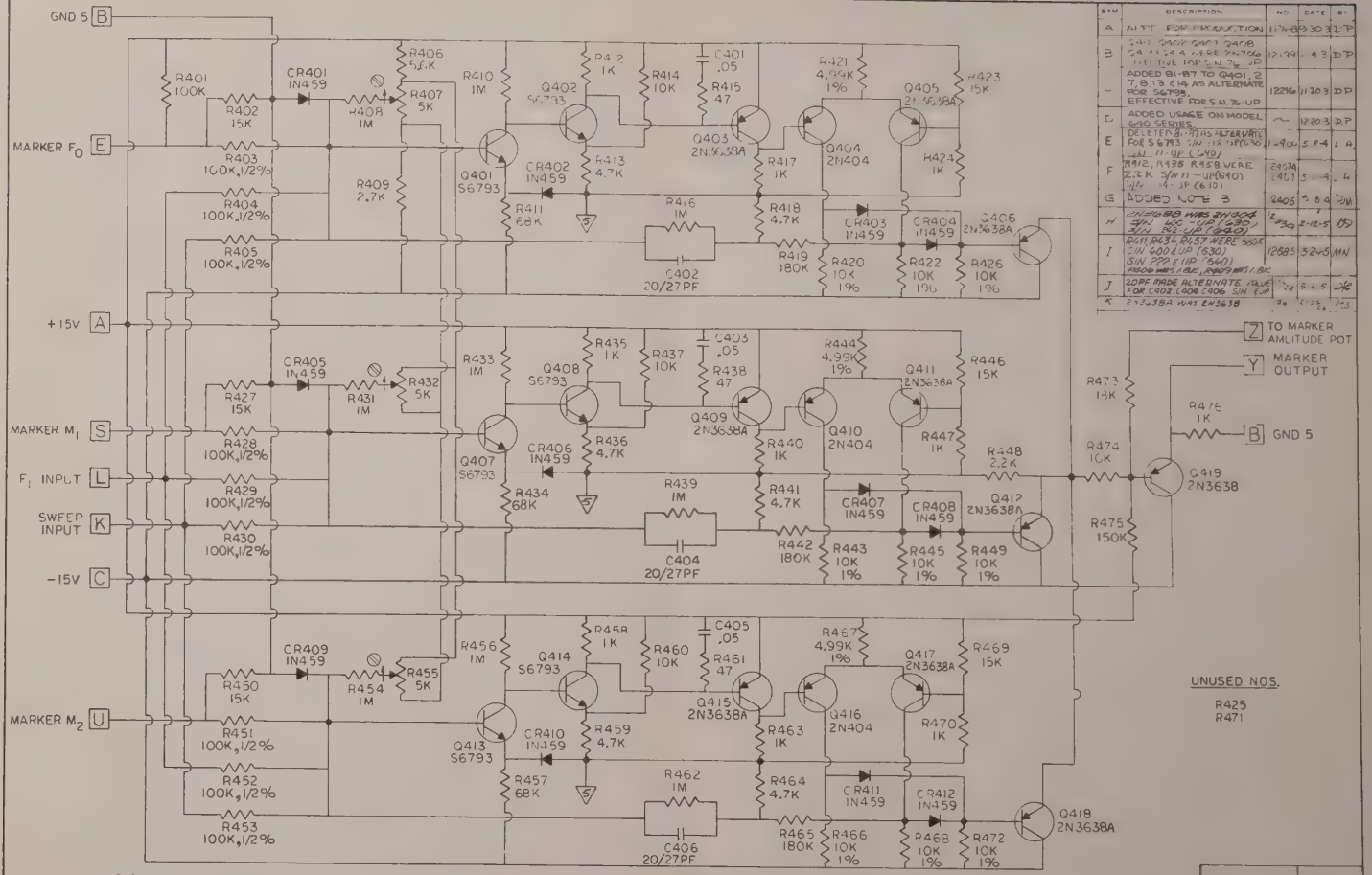
DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

SER NO 11 UP	640
SER. NO. 179-UP	630
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

900600C

SHEET | OF |



SYM	DESCRIPTION	NO	DATE	BY
A	ALTT FOR 1ST PRODUCTION	11-48	8 30 3	JP
B	C401 C403 C405 C408 C414 C416 C418 WERE .05 EFFECTIVE FOR S/N 76 UP	12-99	4 3	JP
C	ADDED Q1-Q7 TO Q401, 2, 7, 8, 13, 14 AS ALTERNATE FOR S6793 EFFECTIVE FOR S/N 76 UP	12216	11 20 3	JP
D	ADDED USAGE ON MODEL 640 SERIES	~	12 20 3	JP
E	DELETED Q1-Q7 AS ALTERNATE FOR S6793 S/N 118 SPEC 640	1-906	5 9 4	L A
F	ADD 11-UP C640) R412, R435 R458 WERE 2.2K S/N 11-UP(640) S/N 14-UP (630)	2407A 2407	5 9 4	L A
G	ADDED NOTE 3	2405	9 16 4	DM
H	CR1-CR8 WAS 2N3604 S/N 119-UP (630) S/N 162-UP (640)	2 730	2-12-5	MD
I	R611 R634 R657 WERE 560K S/N 600 UP (630) S/N 222 UP (640) R606 WAS 1.8K, R607 WAS 1.8K	12685	3 24 5	MN
J	20PF MADE ALTERNATE VALUE FOR C402, C406 C406 S/N 1UP	20	5 2 5	JK
K	2N3638A WAS 2N3638	26	2-25	JK

UNUSED NOS.
R425
R471

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL 1/2% AND 1% RESISTORS ARE METAL FILM TYPE.
   1C. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARE ( ) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC400, ASSEMBLY NO. 950369.
3. ON MODEL 640, S/N 11-119, R427 & R450 ARE 39K.

ITEM	REQD	PART NO	DESCRIPTION

LIST OF MATERIAL

MATERIAL
MATERIAL STOCK NO
FINISH OR TREATMENT

DRAWN Dave Presley 9-27-63
ENG
PROD
SCALE

SCHEMATIC – MARKERS CIRCUIT

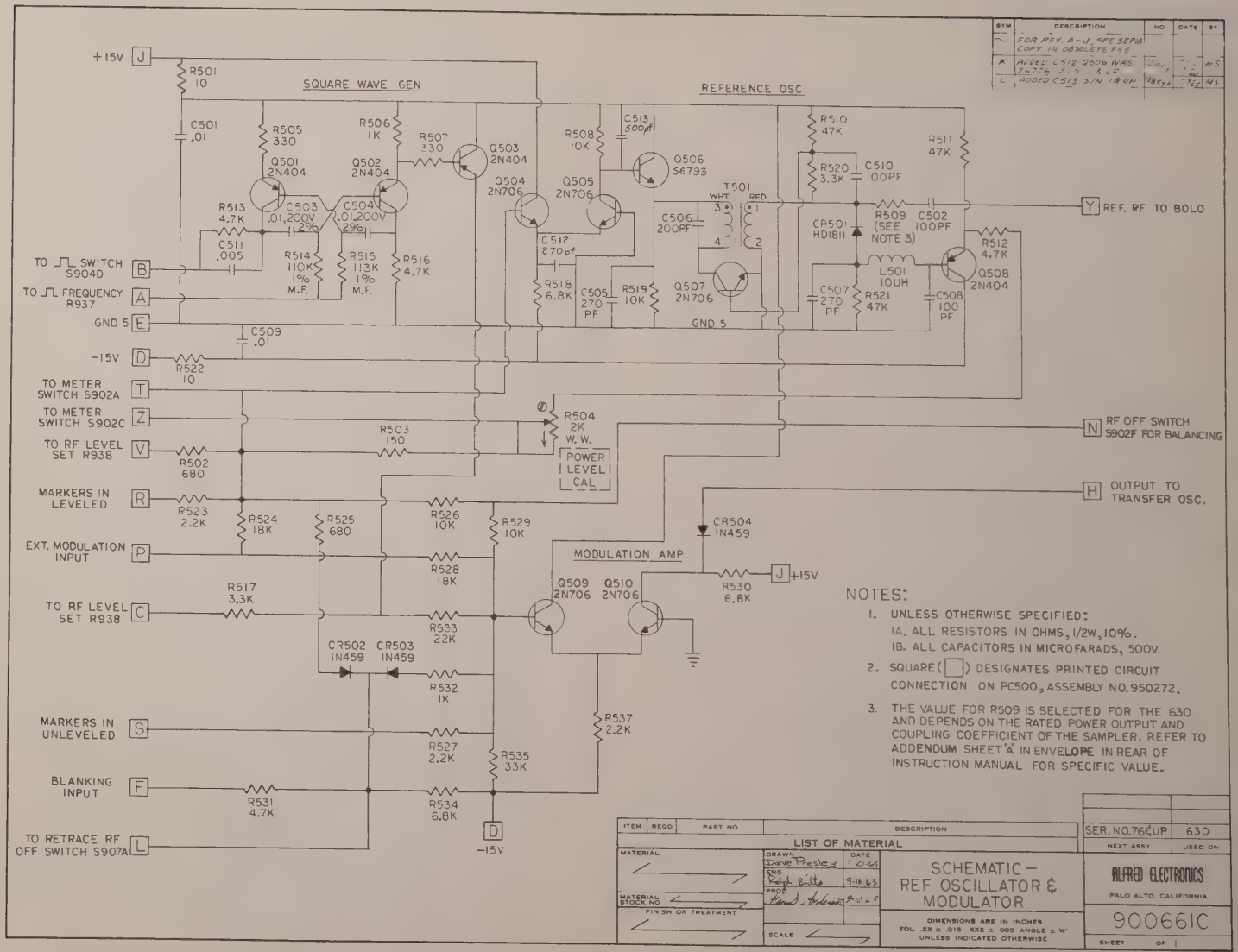
DIMENSIONS ARE IN INCHES
TOL XX ± .015 XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

SER. NO. 11-UP	640
SER. NO. 76-UP	630
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

900652C

SHEET 1 OF 1



SYM	DESCRIPTION	NO	DATE	BY
	FOR REV. A-J, SEE SEPIA COPY IN OBSOLETE FILE			
K	ADDED C512 2200 WAS 2n7Te C.V. & LK			MS
L	ADDED C513 S/N 18 UP	18514		MS

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARE ( ) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC500, ASSEMBLY NO. 950272.
3. THE VALUE FOR R509 IS SELECTED FOR THE 630 AND DEPENDS ON THE RATED POWER OUTPUT AND COUPLING COEFFICIENT OF THE SAMPLER. REFER TO ADDENDUM SHEET 'A' IN ENVELOPE IN REAR OF INSTRUCTION MANUAL FOR SPECIFIC VALUE.

ITEM	REQD	PART NO	DESCRIPTION

LIST OF MATERIAL

MATERIAL

MATERIAL STOCK NO

FINISH OR TREATMENT

		DATE
DRAWN	Dave Presley	7-10-63
ENG	Ralph Bilto	9-10-63
PROD	Frank Anderson	9-10-63

SCALE

SCHEMATIC — REF OSCILLATOR & MODULATOR

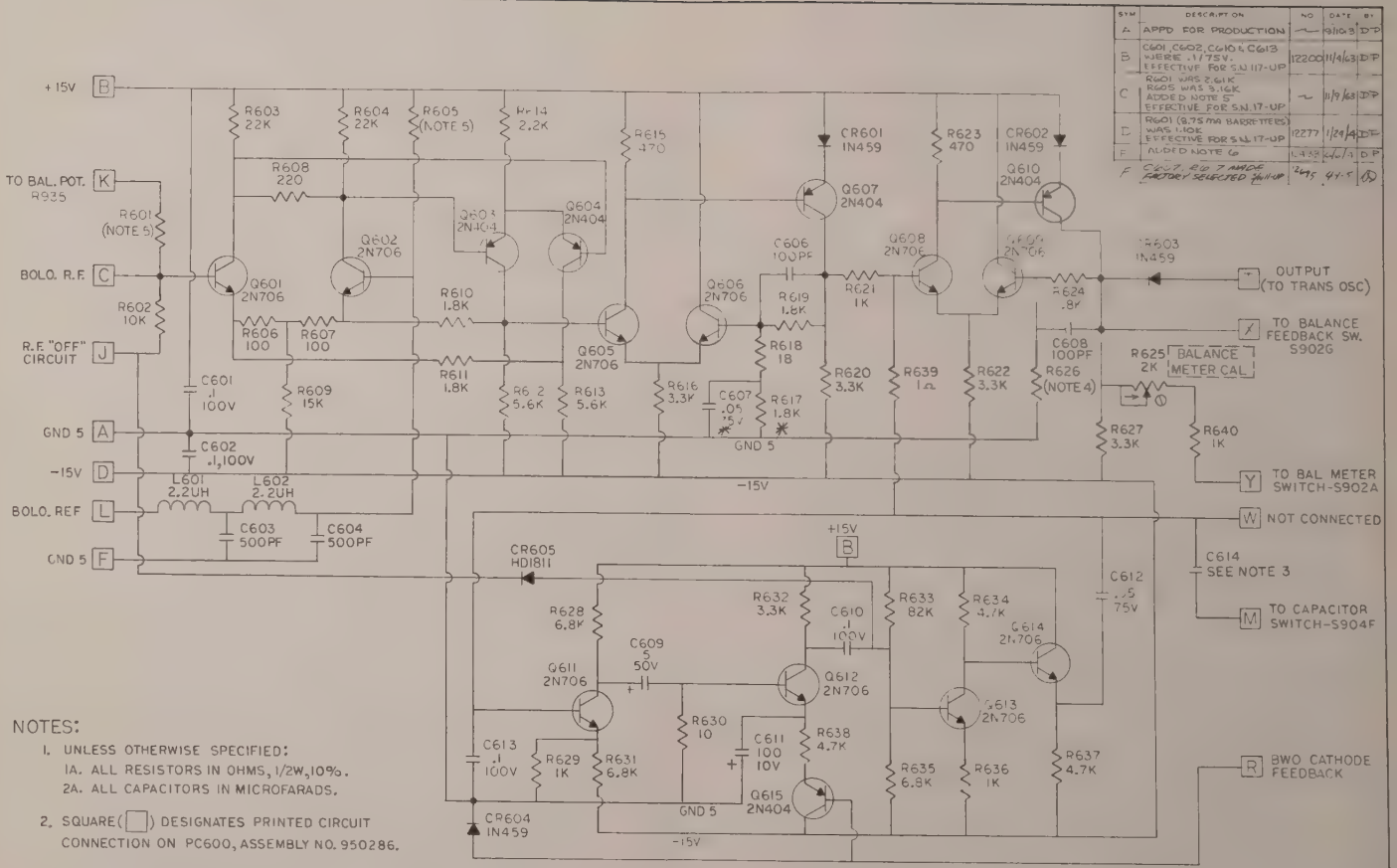
DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

SER. NO. 76 & UP | 630
NEXT ASSY | USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900661C

SHEET OF 1



SYM	DESCRIPTION	NO	DATE	BY
A	APPD FOR PRODUCTION	~	9/10/63	DP
B	C601, C602, C610 & C613 WERE .1/75V. EFFECTIVE FOR S.N. 17-UP	12200	11/4/63	DP
C	R601 WAS 2.61K R605 WAS 3.16K ADDED NOTE 5 EFFECTIVE FOR S.N. 17-UP	~	11/19/63	DP
D	R601 (8.75 MA BARRETTERS) WAS 1.10E EFFECTIVE FOR S.N. 17-UP	12277	1/20/64	DP
E	ADDED NOTE 6	14838	4/1/64	DP
F	C607, R617 ARE FACTORY SELECTED 7/11/64	2475	4/1/64	DP

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   2A. ALL CAPACITORS IN MICROFARADS.
2. SQUARE(□) DESIGNATES PRINTED CIRCUIT CONNECTION ON PC600, ASSEMBLY NO. 950286.
3. REFER TO ADDENDUM SHEET "A" IN ENVELOPE IN REAR OF INSTRUCTION MANUAL FOR SPECIFIC VALUE.
4. THE VALUE FOR R626 IS SELECTED FOR 630A AND DEPENDS ON THE RATED POWER OUTPUT AND COUPLING COEFFICIENT OF THE SAMPLER. SEE NOTE 3.
5. FOR 4.5MA BARRETTERS: R601, 2.61K, 1%-R605, 3.16K, 1%. FOR 8.75MA BARRETTERS--R601, 1.47K, 1%-R605, 1.58K, 1%.
6. FOR MODEL 637 BOTTOM END OF R617 CONNECTS TO TOP OF R613 INSTEAD OF TO GROUND.

* FACTORY SELECTED

ITEM	REQD	PART NO.	DESCRIPTION
LIST OF MATERIAL			

SER. NO. 176 UP 630
NEXT ASSY USED ON

MATERIAL
MATERIAL STOCK NO
FINISH OR TREATMENT
DRAWN Terry Rankin DATE 9-10-63
ENG Ralph B. Hitt 9-10-63
PROD Don Schwartz 9-10-63
SCALE

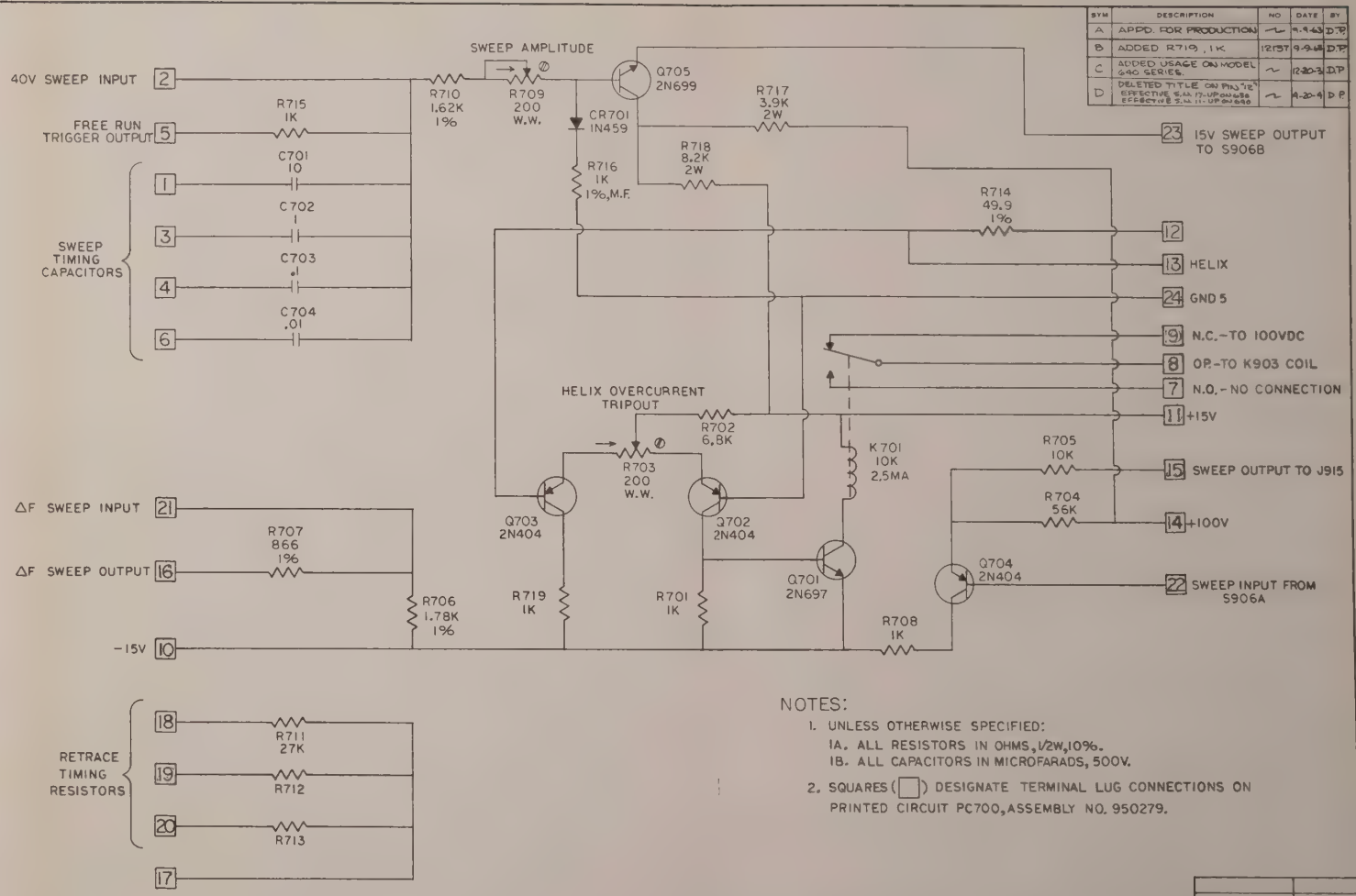
SCHEMATIC — LEVELER CIRCUIT

DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

9006020

SHEET OF 1



SYM	DESCRIPTION	NO	DATE	BY
A	APPD. FOR PRODUCTION	~	9-9-63	D.P.
B	ADDED R719, 1K	12137	9-9-65	D.P.
C	ADDED USAGE ON MODEL 640 SERIES.	~	12-20-3	D.P.
D	DELETED TITLE ON PIN 12 EFFECTIVE S/N 17-UP ON 630 EFFECTIVE S/N 11-UP ON 640	~	4-20-4	D.P.

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARES (□) DESIGNATE TERMINAL LUG CONNECTIONS ON PRINTED CIRCUIT PC700, ASSEMBLY NO. 950279.

ITEM	REQD	PART NO.	DESCRIPTION
LIST OF MATERIAL			

MATERIAL

MATERIAL STOCK NO.

FINISH OR TREATMENT

DRAWN Dave Presley 7-10-63

ENG Ralph Pelle 9-10-63

PROD Wm. L. Hobson 9-10-63

SCALE:

SCHEMATIC — HELIX OVERCURRENT

DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

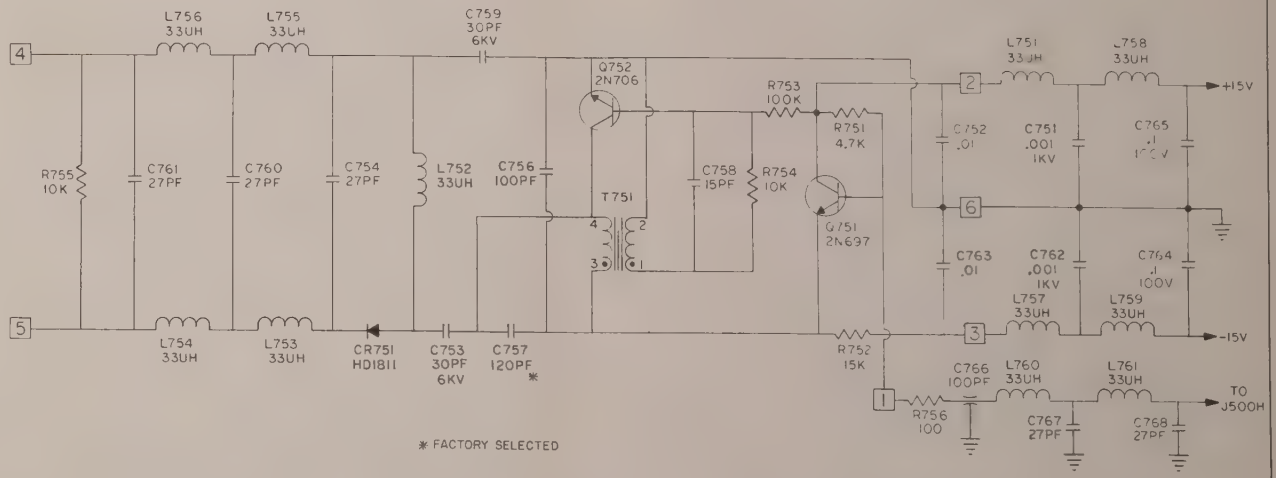
SER. NO. 11-UP	640
SER. NO. 17-UP	630
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900598C

SHEET 1 OF 1

SYM	DESCRIPTION	NO	DATE	BY
A	APPD FOR PRODUCTION	—	9/10/63	DP
B	CHANGED C757 FROM 100PF TO 130PF EFFECTIVE FOR S.N. 386 UP	C 57	9/20/63	DP
C	ADDED L760, L761, C767, C768 EFFECTIVE FOR S.N. 176 UP	C 76	11/16/63	DP
D	C764 & C765 WERE .1/75V EFFECTIVE FOR S.N. 117 UP	2200	11/26/63	DP
E	C757 WAS 130 PF S/N 11 - UP	2020	1-9-64	DP



* FACTORY SELECTED

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 10%.
   1B. ALL CAPACITORS IN MICROFARADS, 500V.
2. SQUARE(☐) DESIGNATES PRINTED WIRING BOARD CONNECTION ON ASSEMBLY 950277.

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

SER. NO. 176 UP	630
NEXT ASSY	USED ON

MATERIAL
MATERIAL STOCK NO
FINISH OR TREATMENT

DRAWN Dave Presley 10-10-63
ENG Paul Beta 9-10-63
PROD [illegible] 9-10-63
SCALE

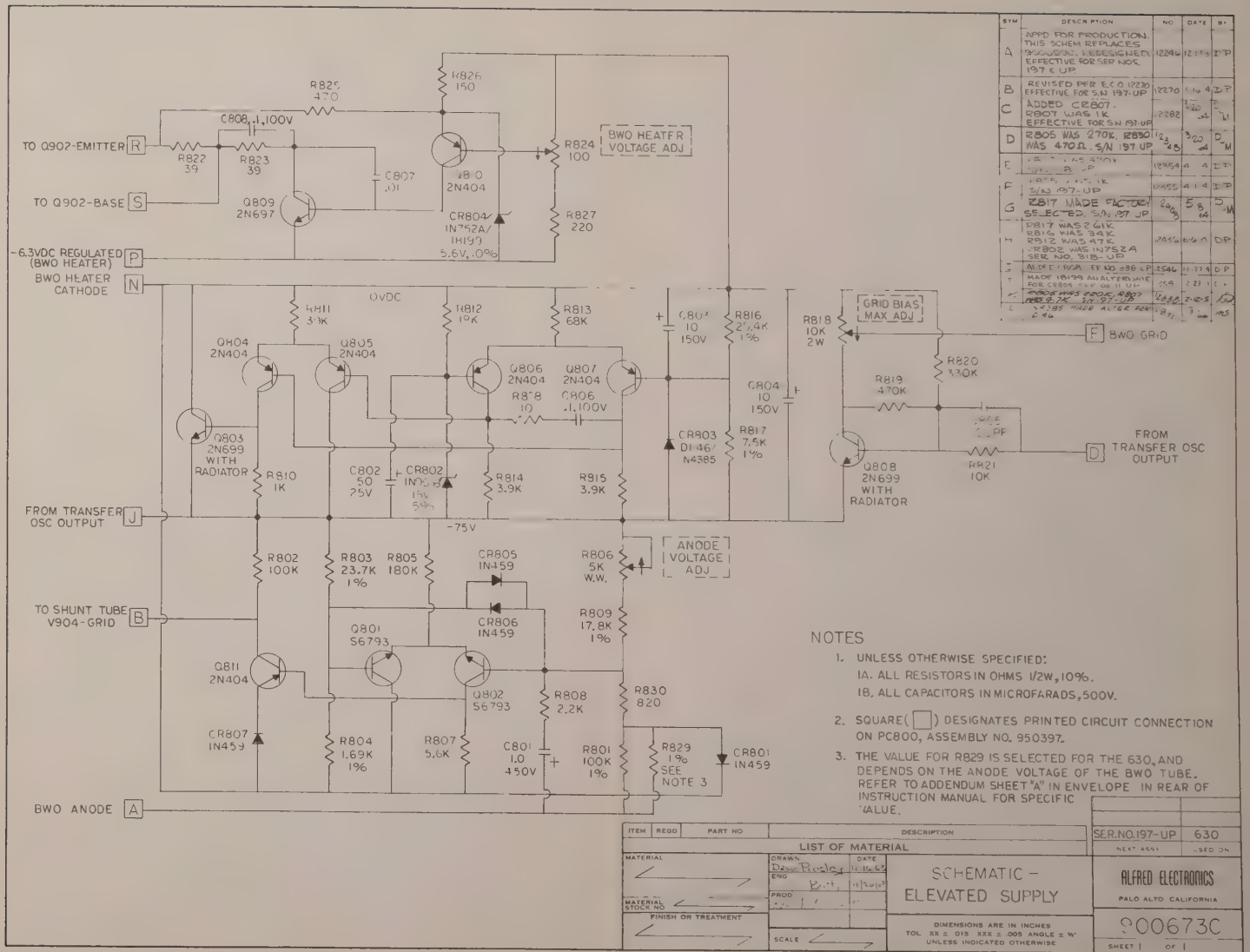
SCHEMATIC—TRANSFER OSCILLATOR

DIMENSIONS ARE IN INCHES
TOL .XX ± .015, .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

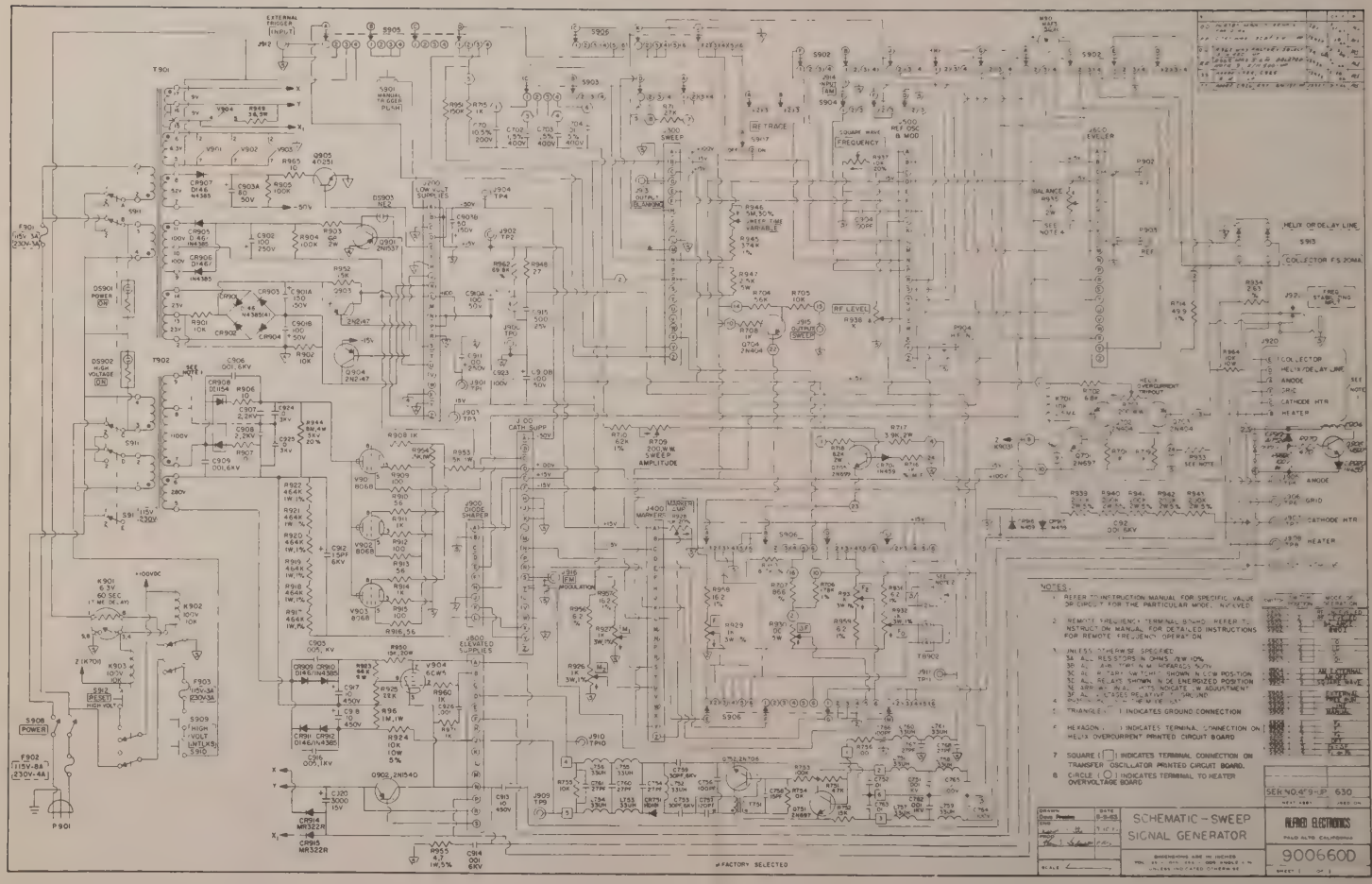
ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

9005970

SHEET 1 OF 1



SYM	DESCRIPTION	NO	DATE	BY
A	APPD FOR PRODUCTION. THIS SCHEM REPLACES 950397-, -, -, -


SCHEMATIC – SWEEP SIGNAL GENERATOR
HEWLETT-PACKARD
PALO ALTO, CALIFORNIA
9006600
SER NO 419-JP 630
NOTES:
1. REFER TO INSTRUCTION MANUAL FOR SPECIFIC VALUE OR CIRCUIT FOR THE PARTICULAR MODEL NUMBER.
2. REMOTE FREQUENCY TERMINAL BOARD. REFER TO INSTRUCTION MANUAL FOR DETAILED INSTRUCTIONS FOR REMOTE FREQUENCY OPERATION.
3. UNLESS OTHERWISE SPECIFIED
4. ALL RELAYS SHOWN IN DE-ENERGIZED POSITION
5. TRIANGLE ( ) INDICATES GROUND CONNECTION
6. HEXAGON ( ) INDICATES TERMINAL CONNECTION ON HELIX OVERCURRENT PRINTED CIRCUIT BOARD
7. SQUARE ( ) INDICATES TERMINAL CONNECTION ON TRANSFER OSCILLATOR PRINTED CIRCUIT BOARD.
8. CIRCLE ( ) INDICATES TERMINAL TO HEATER OVERVOLTAGE BOARD
EXTERNAL TRIGGER INPUT
LOW VOLT SUPPLIES
HIGH VOLTAGE SUPPLIES
ELEVATED SUPPLIES
RF TRACE
SQUARE WAVE FREQUENCY
REF OSC & MOD
RF LEVEL
HELIX OR DELAY LINE
COLLECTOR
ANODE
GRID
CATHODE HTR
HEATER
FACTORY SELECTED

ALFRED

Tube Warranty and Replacement Procedure

Tube Replacement

All TWT and BWO tubes furnished in ALFRED instruments are available from ALFRED ELECTRONICS or the tube manufacturer for either warranty or out-of-warranty replacements. Current prices are given on the Replacement Tube Price List.

Tube Warranty

On ALFRED supplied BWO, TWT, and VTM tubes used in catalog instruments, ALFRED ELECTRONICS extends the full warranty given by the tube manufacturer and offers the following minimum:

Warranty for Huggins, ITT, & Litton TWT's

Tubes are warranted unconditionally against defects in workmanship, materials, and construction for the period shown in Column A and the number of heater hours shown in Column B. To supplement the unconditional warranty, the tubes are warranted on a pro-rata basis for the rated number of heater hours shown in Column C or for one year, both computed from the date of original shipment by ALFRED, whichever expires first. The pro-rated adjustment will be based on the current list price of the tube and the unused percentage of heater hours (Column C) or one-year time period, whichever results in lesser credit.

Warranty for MEC TWT's and All BWO Tubes

Tubes are warranted unconditionally against defects in workmanship, materials, and construction for the period shown in Column A and the number of heater hours shown in Column B. To supplement the unconditional warranty, the tubes are warranted on a pro-rata basis for the rated number of heater hours shown in Column C or for one year, both computed from the date of original shipment by ALFRED, whichever expires first. The pro-rated adjustment will be based on the current list price of the tube and the unused percentage of heater hours (Column C).

Mfg.	Power	A months	B hours	C hours
		TWT		
Huggins	1 - 10 mw	6	500	2000
MEC	1 - 20 mw	6	1000	2000
Huggins	1 watt	6	250	1000
MEC	1 - 10 watt	6	500	1000
Huggins	low noise to 15 db	6	500	2000
MEC	low noise to 15 db	6	1000	2000
ITT	10 watt	2	50	500
Litton	10 watt	6	50	500
		BWO		
All	0.5 - 40 GHz	6	200	2500
		VTM		
Eimac	0.25 - 1 GHz	6	100	1000

WARRANTY CONDITIONS APPLY ONLY TO TUBES LISTED ABOVE WHICH ARE USED IN ALFRED CATALOG INSTRUMENTS.

Return Authorization

TO OBTAIN WARRANTY CREDIT THE TUBE SERVICE REPORT MUST BE COMPLETED AND RETURNED WITH THE TUBE.

Return Procedure

In case a tube or instrument fails, please contact the factory or your local sales representative for advice or authorization to return either the tube or the instrument to the factory. NO TUBE OR INSTRUMENT WILL BE ACCEPTED FOR REPAIR OR CREDIT ADJUSTMENT WITHOUT WRITTEN AUTHORIZATION AND ACCOMPANYING SERVICE REPORT.

When the authorization is received, pack the tube in a rigid container (use original carton if available) at least 4" larger than the tube in each dimension. Wrap the tube with 1/4" of soft padding material and heavy kraft paper before placing in container. Pack at least 2" of resilient dunnage such as rubberized hair, foam, or similar shock absorbing material completely around the tube. Mark the container "FRAGILE" and ship PREPAID via air freight, air express or rail express. Do not ship via parcel post or air parcel post since experience has shown that fragile items are more apt to be damaged when shipped via these methods.

Use similar wrapping, packing and shipping provisions for an instrument. At least 6" of rubberized hair (or equivalent shock absorbing material) is required for an instrument.

In-Warranty Failure - BWO and VTM Tubes

BWO and VTM tubes which fail in warranty will be replaced with a new tube. In case a tube fails, please issue a purchase order for a new tube at the tube list price and return the defective tube. Warranty credit will be issued and deducted from the price, subject to tube manufacturer's verification that failure was caused by tube malfunction. To qualify for maximum credit, it is essential that the defective tube be properly packed and promptly returned.

Repairable or In-Warranty Failure - TW Tubes

If the returned tube is found to be repairable, the user will be asked to issue a purchase order for repair charges determined by the original tube manufacturer. In general, the repair will be at no cost if the tube is in warranty and there is no evidence of misuse or abnormal conditions of operation.

Warranty Credit

Any applicable credit allowed under the terms of this warranty applies only toward the future purchase of a replacement tube from ALFRED ELECTRONICS. Cash settlements will not be made. In terms of this warranty, a replacement tube must be the same type as that on which credit is allowed. Credit for one tube only may be applied toward the purchase of a single replacement tube. Warranty credit remains in effect for a maximum of six (6) months from date ALFRED ELECTRONICS notifies the customer. All credits will be based on the purchase price of the tube which prevails at the time the order for a replacement tube is received by ALFRED ELECTRONICS.

BWO RF Cables

RF OUTPUT CABLE MUST ACCOMPANY BWO TUBES returned for warranty credit, repair or replacement. If rf output cable is NOT returned, the cable price is added to the normal BWO repair or replacement charge. For prices see Replacement Tube Price List.

Special Conditions

If a returned tube or instrument proves not to be defective after test and evaluation at ALFRED ELECTRONICS, the tube or instrument will be returned at the customer's expense.

The final determination as to whether the tube failed in normal operation thereby bringing it under the applicable warranty or whether the tube was misused thereby excluding it from application of the warranty provisions, lies solely with the tube manufacturer.

Data, warranty credit, and prices subject to change without notice.

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ALFRED ELECTRONICS

Service Report

Instrument Model _____ Serial No. _____ Date Received _____

TW/BWO Tube Type _____ Serial No. _____ Date Received _____

Date First Tested _____ Date Placed in Service _____ Date of Failure _____

Total Number of Hours of TWT/BWO Heater Operation _____

_____

1. Was operation normal just prior to failure? Yes _____ No _____
2. If not, what was done to adjust it? _____

   _____

   _____
3. Has proper cooling been maintained during tube operation? _____

   _____
4. Did helix overcurrent tripout occur? _____

   _____
5. Was environment normal? (specify) _____

   _____
6. Symptoms – (describe failure) _____

   _____

   _____
7. Operating conditions at time of failure (indicate any unusual conditions) _____

   _____

   _____
8. Name of person to contact regarding evaluation of failure _____

   Telephone No. _____ Signature _____

   Title _____

   Date _____

ALFRED

Tube Warranty and Replacement Procedure

Tube Replacement

All TWT and BWO tubes furnished in ALFRED instruments are available from ALFRED ELECTRONICS or the tube manufacturer for either warranty or out-of-warranty replacements. Current prices are given on the Replacement Tube Price List.

Tube Warranty

On ALFRED supplied BWO, TWT, and VTM tubes used in catalog instruments, ALFRED ELECTRONICS extends the full warranty given by the tube manufacturer and offers the following minimum:

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Tubes are warranted unconditionally against defects in workmanship, materials, and construction for the period shown in Column A and the number of heater hours shown in Column B. To supplement the unconditional warranty, the tubes are warranted on a pro-rata basis for the rated number of heater hours shown in Column C or for one year, both computed from the date of original shipment by ALFRED, whichever expires first. The pro-rated adjustment will be based on the current list price of the tube and the unused percentage of heater hours (Column C) or one-year time period, whichever results in lesser credit.

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Mfg.	Power	A months	B hours	C hours
		TWT		
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Eimac	0.25 - 1 GHz	6	100	1000

WARRANTY CONDITIONS APPLY ONLY TO TUBES LISTED ABOVE WHICH ARE USED IN ALFRED CATALOG INSTRUMENTS.

Return Authorization

TO OBTAIN WARRANTY CREDIT THE TUBE SERVICE REPORT MUST BE COMPLETED AND RETURNED WITH THE TUBE.

Return Procedure

In case a tube or instrument fails, please contact the factory or your local sales representative for advice or authorization to return either the tube or the instrument to the factory. NO TUBE OR INSTRUMENT WILL BE ACCEPTED FOR REPAIR OR CREDIT ADJUSTMENT WITHOUT WRITTEN AUTHORIZATION AND ACCOMPANYING SERVICE REPORT.

When the authorization is received, pack the tube in a rigid container (use original carton if available) at least 4" larger than the tube in each dimension. Wrap the tube with 1/4" of soft padding material and heavy kraft paper before placing in container. Pack at least 2" of resilient dunnage such as rubberized hair, foam, or similar shock absorbing material completely around the tube. Mark the container "FRAGILE" and ship PREPAID via air freight, air express or rail express. Do not ship via parcel post or air parcel post since experience has shown that fragile items are more apt to be damaged when shipped via these methods.

Use similar wrapping, packing and shipping provisions for an instrument. At least 6" of rubberized hair (or equivalent shock absorbing material) is required for an instrument.

In-Warranty Failure - BWO and VTM Tubes

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Repairable or In-Warranty Failure - TW Tubes

If the returned tube is found to be repairable, the user will be asked to issue a purchase order for repair charges determined by the original tube manufacturer. In general, the repair will be at no cost if the tube is in warranty and there is no evidence of misuse or abnormal conditions of operation.

Warranty Credit

Any applicable credit allowed under the terms of this warranty applies only toward the future purchase of a replacement tube from ALFRED ELECTRONICS. Cash settlements will not be made. In terms of this warranty, a replacement tube must be the same type as that on which credit is allowed. Credit for one tube only may be applied toward the purchase of a single replacement tube. Warranty credit remains in effect for a maximum of six (6) months from date ALFRED ELECTRONICS notifies the customer. All credits will be based on the purchase price of the tube which prevails at the time the order for a replacement tube is received by ALFRED ELECTRONICS.

BWO RF Cables

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Special Conditions

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The final determination as to whether the tube failed in normal operation thereby bringing it under the applicable warranty or whether the tube was misused thereby excluding it from application of the warranty provisions, lies solely with the tube manufacturer.

Data, warranty credit, and prices subject to change without notice.

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ALFRED ELECTRONICS

Service Report

Instrument Model _____ Serial No. _____ Date Received _____

TW/BWO Tube Type _____ Serial No. _____ Date Received _____

Date First Tested _____ Date Placed in Service _____ Date of Failure _____

Total Number of Hours of TWT/BWO Heater Operation _____

_____

1. Was operation normal just prior to failure? Yes _____ No _____
2. If not, what was done to adjust it? _____

_____

_____

3. Has proper cooling been maintained during tube operation? _____

_____

4. Did helix overcurrent tripout occur? _____

_____

5. Was environment normal? (specify) _____

_____

6. Symptoms - (describe failure) _____

_____

_____

7. Operating conditions at time of failure (indicate any unusual conditions) _____

_____

_____

8. Name of person to contact regarding evaluation of failure _____

Telephone No. _____ Signature _____

Title _____

Date _____

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED products are warranted against defects in workmanship and materials. This warranty is limited to repair or replacement of products or parts (except tubes, transistors, and batteries) which prove defective within one year after delivery to original purchaser. ALFRED ELECTRONICS is not liable for consequential damage.

If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information, you will be sent service instructions or shipping data.

2. Upon receipt of shipping instructions, forward the instrument prepaid and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local transfer and storage company may be employed.